Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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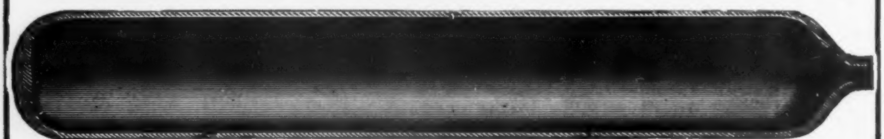

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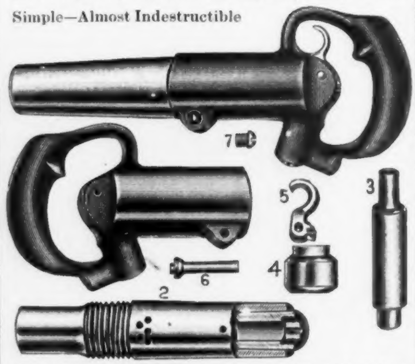

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M. E. VARIAN, }

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Accidents due to Combustion within Air Compressors.

Dr. Ledoux, in a paper read before the American Institute of Mining Engineers, gives an interesting account of a serious accident which might occur in almost any common mining plant, provided due precautions are not observed. In the first place, it is very likely, though not stated, that the air compressor in question was not a compound machine; that is, the air was not compressed in stages. This is the first point to consider when equipping a mine with an air compressor, and where the purchaser wishes to be insured against a similar occurrence. By compressing the air in stages, that is, by the use of compound cylinders, the maximum temperature during compression is very much reduced and the liability to "flaming" is less. Having an air compressor with compound cylinders, the next thing to do is to provide a high grade of oil to be used in the cylinders. This should be an oil with a high flashing point and of a non-coking nature. In other words, when the oil is placed on a shovel and held over a fire there should be little or no carbon deposit left after it has been volatized. The third point to be observed is to caution the engineer not to use much oil in the air cylinders. A drop every five minutes is sufficient in a cylinder of ordinary size, and every engineer should feed soapsuds into his cylinders for at least one day in the week in order to wash away any deposit which may have accumulated through the use of oil which has been acted upon by high temperatures in air. These soapsuds may be fed through the regular oil cup. Care should be taken not to let the machine lie idle with soapsuds remaining in it; that is, shortly before quitting time the feeding of soapsuds should be stopped and oil feeding substituted.

Another point is that every engineer should look into his discharge valves, air-receiver and other places where deposits are liable to accumulate, and keep them clean. A discharge valve which sticks, either through defective construction or through the accumulation of carbon around it, is liable to admit hot compressed air from the receiver back into the cylinder to increase the temperature of the air before compression to so high a point that it is quite possible to reach the flashing point of the oil. In connection with this, it is well, also, to bear in mind that the intake air should come from the outside and not from the inside of the engine room. This is important, because a cold intake gives a higher volumetric efficiency to the compressor and also because it results in a lower maximum temperature during compression, which

not only means safety against "flaming," but economy of power. The hotter the air is during compression the greater is the resistance to compression. Another reason for an outside intake is that bad air in the engine room, or smoke or fumes from a fire, will not be sucked into the compressor and discharged into the mine.

This case also illustrates the value of intercoolers and aftercoolers in a compressed-air plant. These coolers are surface condensers, the intercooler being placed between the high and low-pressure air cylinders and serving to reduce the temperature between the two stages of compression. The aftercooler reduces the temperature after the last stage and condenses and collects all such foreign matter as oil, moisture, dust, etc., sending pure, dry air down into the mine.

Utilizing Tidal Action.

While many minds have labored vainly to find some practical means of bringing about the conversion of the tidal action into mechanical energy for general transmission and use, the day may come when this apparent wholesale waste of energy will be ended and the power of the tides brought into control becoming a prominent factor in the generation of power for the commercial and mechanical world. Various methods to accomplish this end have been devised in past years, but, while some of them have actually been shown to work successfully in fact as well as in theory, there has always been some unsurmountable barrier, as exceptional conditions or prohibitive cost, which prevents their general use.

Most inventors have confined their efforts to some mechanical device which will transform the action of the tides into some form, generally electricity, that may be easily transmitted. It remains for an engineer of Mons, Belgium, Chas. Eugene Ongley by name, to devise a method of compressing air directly by the rise of the tides. His idea is to construct a tunnel or reservoir with a comparatively small opening at the low-water mark. As the tide rises the water flows into the tunnel or reservoir covering the opening and gradually compressing the air in the top of the receptacle from which, with the aid of a proper outlet valve and piping, it can be conveyed under pressure to another reservoir. While the inventor admits that the pressure thus obtained would not be very great, 25 to 30 pounds at best, he believes that his idea could be profitably utilized along the Atlantic sea board.

While we do not doubt the practical working of this method, yet we believe that it would not pay to install it generally, because its application is very limited. There are only a few places where it could be put into operation, and in all places both the pressure and the volume would be small. Furthermore, there is no special commercial advantage in a compressed air plant which is located down at the seashore some miles away from the point of consumption. As the rise and fall of tide takes place only twice in 24 hours, the volume of compressed air which might be produced by this process would be small in proportion to the expense involved. In other words it would be necessary to confine large volumes and to construct expensive works, which from a commercial standpoint would hardly be likely to compare favorably with the production of compressed air by means of engines of high duty, working directly at the point where the air is utilized.

A more extended description of Mr. Ongley's invention, with illustrations, will be published in the July number of Compressed Air.

Notes on Accidents due to Combustion within Air Compressors.*

With the improvements in design and efficiency of machinery the element of danger in its use is becoming less, but it is a question whether the strain involved in operating modern plants is not increasing somewhat the danger of accident due to human fallibility.

I propose to describe a somewhat uncommon casualty resulting from a not infrequent incident in the use of air-compressors. It is not necessary to state the location of the mine in which the accident occurred nor the makers of the compressor, and the object of this brief paper is more to draw out suggestions from members more familiar than am I with the practical handling of mining machinery than to point a moral.

The compressor in question was a three-drill machine of standard make. At the time of the accident it was furnishing air to a single drill working in an upraise from a well-ventilated tunnel, and giving ventilation to a winze below the tunnel where two men were hand-drilling. The compressor also furnished power to a small hoist in the winze, but the hoist was only operated occasionally, and never while the drills were working. The drills were located about 1,200 feet from the compressor. The engineer testified that he never had been short of air and that there had been no complaints that the machine was inefficient. The engineer testified, further, that the water used in cooling the air-cylinder had never become greatly heated, but that he used a mixture of good cylinder-oil and of a lighter grade known as "Atlantic Red." The valve of the compressor was set to blow off at 80 pounds. He was eating his luncheon in the boiler-room when he heard a "crack like a pistol," and, going into the engine-room, found water spurting out of the jacket about two feet from the end of the compressor. He tightened the jacket and stopped the leak, and found that the jacket was perfectly cool. He next noticed that "grease began to fry on the pipe and receiver."

He next saw that the air-pipe had become red-hot, the heat extending to a point where the pipe went through a wooden partition, setting fire to it. Then he noticed that the pressure was going down "just as quick as if some one had opened a valve outside," which, in fact, is what happened. He stopped the engine, but, getting the signal for more air, started up again. It is well to note at this point that the intake of the compressor was in the engine-room, the temperature of which usually stood at 115° F.

Let us now see what occurred in the mine. What happened at the bottom of the winze cannot be better told than in the testimony of one of the miners at the Coroner's inquest: "I was turning a hole and my partner was striking the drill; he says, 'We ain't got much air here this morning; I will ring for some more air.' He rang, started to strike again, and struck two or three blows; straightened up and took a couple of breaths of air, and started in to strike again, and then quit. I had been joshing him, and says, 'You ain't as tough as you used to be.' I stood up, picked up a pick, struck two or three blows and felt that the air was bad. Just then the air stopped, and the hoist-tender hollered to us that there was no air and we had better come up. I looked around and seen my partner standing in the corner. He was all trembling, and I caught him as he fell over."

These two men were gotten up by heroic work on the part of comrades, and their lives were saved. But not so fortunate were the men in the upraise. There were four of them here, and when they felt the air getting bad they opened the valve full—of course, only increasing the difficulty. They were experienced miners, and at first could not understand what was the matter with them, because their candles continued to burn as usual. This was due, undoubtedly, to the fact that they were working in an upraise, and that the heavy carbonic-acid gas sank, and perhaps to the fact that carbonic oxide may have been generated through incomplete combustion or the reduction of the carbonic acid, first formed, by the glowing carbon in the pipe.

Two men were killed and four others barely escaped with their lives as a result of the combustion of the oil, deposited carbon and organic dust accumulated in the compressor, receiver and pipe. Explosions of air-compressors due to this cause have been frequent, and lives have been lost thereby; and what is known as the "flam-

* By Albert R. Ledoux, for the Albany Meeting, February, 1903, of the American Institute of Mining Engineers.

ing" of compressors or cylinders is an every-day experience, and in some cases the rupture of the air-pipes, but, so far as I can ascertain, without the serious consequences described in the present case.

I shall leave to those better qualified than I the discussion of the best means of preventing such catastrophies. Among those which suggest themselves are the taking in of the air from a point where its temperature is as low as possible, the introduction of auxiliary coolers, the use of as heavy oil as possible—yet never in excess—the cleaning out of cylinders, receivers and pipes, and especially a warning to the engineer to be very sure, when he receives a signal for more air, that the actual shutting-down of the compressor may not be more essential. In this case, had he shut down it is probable that no lives would have been lost, for with the stopping of the air the miners would have at once returned to the tunnel level.

Sand-Blast Cleaning of Structural Steel.*

CHARLES EVAN FOWLER, M. Am. Soc. C. E. (by letter).—This paper is certainly one of the most important that has ever been presented before the Society. The failure to clean the metal of steel structures properly before they are painted is the principal cause of their deterioration, and, practically, is the only cause which exists as a prejudice against them. While the bridge shops have, in most instances, endeavored to clean the steel properly before paint is applied, it has never been done satisfactorily, in the majority of cases, owing to the character of the plant used, and owing to the character of the help which it is necessary to employ on work of this kind. The laborers ordinarily employed as painters about bridge works are not possessed of a very high order of intelligence, and soon fall into the rut of glossing over and slighting their work. When they are discharged, and new ones put in their places, there is always a length of time for breaking them in, during which the work is not done properly, so that the writer believes that, necessarily, it must come to some such method as sand-blast cleaning at the bridge shops before painting is done, or else follow the lead of some European railroads, where the bridges are not painted until some time after erection.

The specifications of the Sheffield and Lincolnshire Railway Company for 1889 require that no portion of a structure shall be painted before erection, except such parts as are not accessible for painting afterward. Some time after the structure is erected, and the scale has all disappeared by rusting off, the metal is cleaned thoroughly and painted. Should this be done by the sand-blast process, and paint at once applied, there would be some surety of a proper protection from future rusting.

Many engineers seem to object to allowing rust to appear upon the steel at all, preferring to have the metal kept under cover from the time it is rolled until it is fabricated and painted, but any one who has had experience with raw steel plates and shapes stored in a yard will know that the mill scale, which very often is not removed otherwise, is rusted off, and the solid metal, although coated with rust, can be gotten at so as to be cleaned thoroughly and painted; whereas, if the metal is kept under cover, much of this scale remains on and is painted over, and in a few years flakes away from the metal, or rusting between the scale and the body of the metal goes on unseen.

In the writer's opinion, particular parts of bridges should be galvanized, in a great many cases, or protected by Barffing, so as to give them a protection once for all; but, in lieu of this, the thorough cleaning of existing structures by a method similar to that used by Mr. Lilly should be followed, and the coating applied directly afterward to protect the steel thoroughly. In such cases it will be possible soon to arrive at some definite idea as to which paint is really the best to use on bridges and steel structures.

While not directly a feature of Mr. Lilly's paper, it certainly is one which comes up in studying it, as to what kind of paint is really the best. The writer is not prepared to change his opinion, formed during many years as chief engineer of one of the large Eastern

*Abstract from *Proceedings* American Society of Civil Engineers for April, 1903.

This is a discussion of the paper by George W. Lilly, Assoc. M. Am. Soc. C. E., printed in *Proceedings* for February, 1903, and also reprinted in April, 1903, "COMPRESSED AIR."

bridge companies, that red-lead paint is the best that can be applied, regardless of the numerous paints which are advertised so loudly as the best for protecting steelwork. Red lead, used according to the Baltimore and Ohio specifications of 1896, by the addition of 10 oz. of lampblack to every 12 lbs. of red lead, can be handled as easily as any other paint. Next to this, for first-class work, are the various carbon paints put on the market by the standard paint companies.

While the writer has no data of his own as to the cost of sand-blast cleaning, it appears from the paper that the cost can be reduced to a reasonable figure, and one which would warrant the use of the method whenever there is a large amount of cleaning to be done.

If this paper shall have served no other purpose than to have called attention in a forcible way to the need of thorough cleaning of steelwork before painting, it will have proved itself to be one of the most valuable papers ever presented for the consideration of engineers having to do with steel structures.

William Anderson Polk, Assoc. Am. Soc. C. E. (by letter).—The writer has read this paper with much interest, especially that part relative to cleaning the One Hundred and Fifty-fifth Street Viaduct, in New York City. During this operation the writer had the pleasure of devoting about one month's time to observation of the workings of the sand-blast, and found that it was the only power capable of removing the accumulated rust scale with despatch and economy. Moreover, it was the only method that was thoroughly efficient in preparing the surface for the tests of paints, that being the object for which the sand-blast was used on the viaduct.

To understand how thoroughly the machine did its work, it may be stated that on days in which the humidity was great (such days were frequent, the humidity registering often from 90° to 98°), the metal was no sooner cleaned than the gray color was changed by oxidation to a rusty brown. It was deemed expedient to apply the paint as soon as possible after a sufficient number of square feet (about 200) had been cleaned. This surface would comprise two buckle-plates, one on each side of the girder, and the section of the girder supporting these buckle-plates. The cleaned surface was protected from sand by a screen of sail cloth while the machine was being operated.

Notwithstanding this protection, a great deal of fine dust settled on the cleaned portion. This dust was readily taken up by the paint, however, and, in the writer's opinion, did no harm. One painter could finish in two hours the portion which had been cleaned by one nozzle-man in eight hours, under favorable conditions, viz., in dry weather and with dry sand. Four nozzle-men could keep one painter busy, but, to accomplish this, the sail-cloth screen had to be moved frequently to places where protection might be necessary. On bridges at other places the writer has noticed that a screen was not needed.

The expense of cleaning the One Hundred and Fifty-fifth Street Viaduct was necessarily much greater than it would be to-day. The cost and the time of cleaning could be reduced very much by the addition of more machines.

For the purpose of preparing metal surfaces for painting, nothing has come under the writer's observation, during a period of ten years, that can approach the efficiency of the sand-blast machine. In order to have the best results from painting, it is expedient, nay, it is necessary, to have the surface absolutely free from rust, mill scale and grease; therefore the sand-blast will more than pay for itself in decreased maintenance and in furthering the lasting qualities of metal coatings.

J. P. Snow, M. Am. Soc. C. E. (by letter.—The Boston and Maine Railroad (with which the writer is connected) has used a sand-blast outfit for four seasons, but from its experience little can be added to the testimony given by the author. The mixers used are of the Tilghman pattern, with a second hopper, so that sand may be fed continuously while the blast is operating.

The air is furnished by a Fairbanks-Morse gasoline compressor, with an 11-inch engine cylinder and a 14½-inch pump having an 18-inch stroke. Two, and sometimes three, open-topped galvanized-iron tanks, of 600 gallons capacity, each containing circulating water for cooling the cylinders, are used; these, and a small galvanized-iron gasoline holder, a boiler-iron air-reservoir,

a sand-dryer, and pipes, hose, etc., complete the outfit.

The air pressure with this plant is from 15 to 18 pounds, which is very effective on weather rust not heavily scaled. Where the scale is caused by engine gases or by brine from refrigerator cars it is removed with hammers, chisels, etc., before applying the blast. It is thought that a greater pressure, as advocated by Mr. Lilly, would be more effective where the rust is heavy and the metal pitted. The pressure can be increased by exchanging the pump cylinder for a smaller one.

Usually this outfit is loaded and unloaded by a car derrick. It is set up near the bridge to be operated upon, the water tanks are filled from the locomotive tender, a detachable shanty is put over the engine, sand is unloaded, the pipes are connected, and work is commenced. It requires only a few hours to set up the plant at a given bridge. It is desirable to have the sand-dryer as near the bridge as possible, but the engine should be 100 feet away or further, to get it somewhat out of the dust.

The sand should be clean and hard. For the highest efficiency, its fineness should depend on the kind of rust to be attacked. For simple weather rust, fine sand is the best. If the rust is heavy, the metal pitted and the surface hard to get at, coarse sand should be used. Where the work is over dry land, the sand can be used again several times. It gets finer each time it is used, but as the impact against the metal breaks the grains of sand, they are sharp, and, until it becomes too fine, its effectiveness is rather greater than at first.

For drying sand a so-called Chicago dryer is used. The dry sand escapes through an annular opening against the fire-box, which prevents, in a measure, the overheating mentioned in the paper. This method of drying sand is very unscientific, however, inasmuch as the mass of sand in the hopper acts as a blanket to prevent the escape of steam from the lower portion next to the fire-pot, where there is the greatest heat. In fact, it is a good deal like trying to drive moisture out of a steam-tight box. A dryer arranged so that the sand could fall over a series of inclined baffle-plates in a furnace, where the heated gases from the fire could pass over a thin moving sheet of sand and absorb its moisture, is a desideratum. The waste heat from the engine exhaust is enough to dry the sand in a properly arranged dryer, but there are practical difficulties in using it. The exhaust from an explosion engine should be free and close to the engine, to obviate back pressure; but, to save the running parts, the engine should be at some considerable distance from the sand. Again, it is frequently desirable to dry sand when the engine is not running; therefore, on the whole, it seems best to use an independent dryer.

Some difficulty is experienced from moisture carried by the condensed air. A very little dampness will cause the sand to clog at the lower valve, as mentioned in the paper; but, with drips at the air reservoir and no sags in the lines of air pipes, the trouble is not great.

In cleaning a long bridge the air has been carried as far as 900 feet from the reservoir. A 3-inch pipe is used, and there is very little reduction in the pressure from the reservoir to the mixers.

The operation of painting is similar to that described by Mr. Lilly. On overhead bridges, which suffer from the blast action of the locomotive smokestacks, it is not considered a disadvantage to have the sand get into the raw paint. Two coats are applied, and the portion directly over the centres of the tracks receives three coats. If the first is well filled with sand the result is a thick, gritty coat, which has considerable power to withstand the blast of hot sparks from the stacks.

With the engine described, three mixers and nozzles are used. The force required is generally a foreman and six men—three on the nozzles and three drying sand and feeding it to the mixers. The writer has no reliable statistics as to cost. The figures given in the paper are fairly comparable with average results obtained, but many jobs cost more on account of the difficulty of getting at the parts to be cleaned. The question simply resolves itself into a choice between letting the metal waste away at its own rate or paying the cost of cleaning it with the sand-blast. Where iron has become heavily scaled by locomotive

gases, brine from beef cars, or sea water, it is simply impracticable to stop corrosion by any method known to the writer other than the sand-blast.

THEODORE BELZNER, Jun. Am. Soc. C. E.—In this paper Mr. Lilly has carefully covered the ground, and has left little to be added except practical experiences in the same line. A number of his recommendations should be carried out, and if criticism were to be made, it would have to be said that he does not place sufficient emphasis on some of his recommendations.

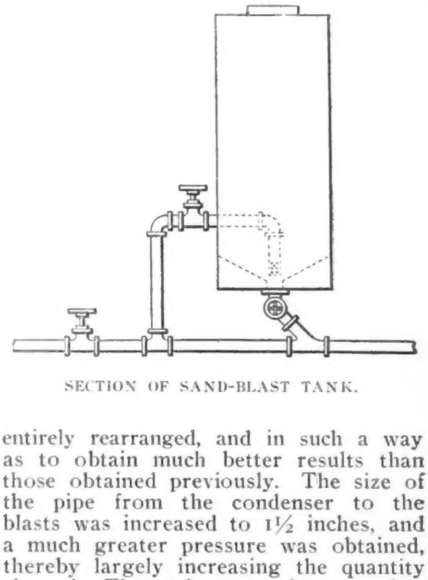
The speaker will endeavor to relate the experience gained in the sand-blast cleaning of steel on the Rapid Transit Subway, in New York City.

Owing to the magnitude of the Rapid Transit Subway work, steel had to be ordered largely in advance from the manufacturers, who in this case were the American Bridge Company. Such steel as columns and girders of standard size and design were ordered, so as to facilitate the output at the mills. Large quantities were received, and lay for from eighteen months to two years, piled high in the streets and at the yard at the foot of Forty-second street, East river. This steel was exposed to the inclemency of the weather for that period. When the sub-contractors were ready to use the steel it was found that the paint had worn off considerably and a part of the steel was corroded. It was determined to clean and repaint before erection such parts as were to be exposed in the structure, and all abutting and connecting parts which were not to be embedded in concrete. S. L. F. Deyo, M. Am. Soc. C. E., Chief Engineer for the Rapid Transit Subway Construction Company, acting on the recommendation of William Barclay Parsons, M. Am. Soc. C. E., Chief Engineer for the Rapid Transit Commission, then gave the order to the sub-contractors to clean the steel with the sand-blast.

Before taking up the work in detail it should be stated that the various sub-contractors had established air-compressing plants on their various sections, thus having their line covered with compressed-air pipes.

A large quantity of steel was piled at Canal and Elm streets, and work was commenced there, but was found to be such a nuisance to the tenants of surrounding buildings and to traffic that it was moved down into the partly finished subway. Here the dirt and sand became a hindrance to the workmen, and the work was moved to Bond and Elm streets. Here, again, it proved to be such a nuisance to the public and to traffic that the operation of the blast was confined to night hours. Work was then carried on at this point for a long time, until the street was cleared for paving. The plant was then moved to Forty-second street and the East river, where again work during the day was found to be objectionable to the neighborhood, and the work is now being done at night.

The plant, after being moved to Forty-second street and East river, was entirely rearranged, and in such a way as to obtain much better results than those obtained previously. The size of the pipe from the condenser to the blasts was increased to 1½ inches, and a much greater pressure was obtained, thereby largely increasing the quantity cleaned. The tanks were about 200 feet from the power-house. The arrangements for drying and storing sand ready for use were also improved, and the handling was facilitated considerably by the use of the crane in lifting and piling the steel.



SECTION OF SAND-BLAST TANK.

Two plants are at work. That for The Degnon-McLean Contracting Company consists of four tanks of double-row, riveted, extra heavy, ordinary kitchen boiler, 14 inches in diameter and 4 feet

10 inches long, the interior arrangement of which is shown in the illustration on page 2419. The plant in use by the Holbrook, Cabot & Daly Contracting Company consists of two tanks having a similar interior arrangement.

Although four tanks were erected for The Degnon-McLean Contracting Company, only two are in use, as a rule, the extra tanks being kept in reserve in case of any trouble, thereby preventing any interruption of the work.

The simplicity of the design of these sand tanks should recommend itself to engineers, because any mechanic can look after them, thus avoiding the use of patented devices such as described by Mr. Lilly.

Great care has been taken in the selection of the sand. That coming from the shores of Long Island Sound has proved to be the best for the purpose desired. The arrangements made for drying the sand consist of an open brick flue, about 3 feet wide and 20 inches high, on which are placed two iron trays. These trays are of ¼-inch iron, and each is 6 inches deep, 3 feet 6 inches wide and 4 feet long.

Great care should be taken in drying the sand. It should be turned over continually, which in this case had to be done by hand. When dry it should be removed from the pans at once, and not allowed to burn or bake, for in that case when it came into impact with the steel it would be brittle, and, battering into fine dust, would not remove the rust. Sand dried properly and carefully can be used two or three times with good results. In a permanent plant a rotary dryer, over a fire, or supplied with a hot blast, could be used very economically, and the drying would be more uniform.

A section, about 6 inches in diameter, was cut out of the crown of each blast tank and a screw cap fitted to the opening. This is removed while the tanks are being filled. The sand is passed through a fine wire mesh before being poured into the tanks, so that nothing can pass through that will tend to choke or obstruct the valves and fittings.

The outlet for the sand is at the bottom and centre of the tank, and is of 1½-inch pipe, connecting below with the air-pipe at an angle of about 45 degrees. About 6 inches above the outlet another connection is made through the side of the tank by a 1-inch pipe extending to the centre of the tank, with an elbow, the end looking down into the outlet. This pipe and elbow are perforated with small holes, and air under pressure and controlled by a valve is admitted, so as to keep the sand slightly agitated, thereby facilitating its flow through the outlet.

The sand flows from the tanks through a flexible rubber hose of 2½ inches internal diameter, to the end of which is attached an ordinary pipe reducer to receive the nozzle; it passes out at a uniform pressure of 65 pounds per square inch. This pressure is furnished from the power-house erected for the purpose of supplying power for the work being done on Park avenue and Forty-second street.

In front of the tank a platform of 2-inch timber, 25 by 50 feet, was built. On this the pieces of steel are placed side by side, and when the upper sides are cleaned, the pieces are turned over and the opposite sides cleaned. When cleaned, the steel is painted, and then removed and piled by the crane.

Nozzles of extra heavy ½-inch gas pipe, varying from 7 to 18 inches in length, have been used, but it has been found that the 12-inch lengths are most effective. The life of the nozzles varied with the sharpness of the sand, the temper of the pipe material and the air pressure, but, on the average, lasted 1½ hours. The nozzles were generally worn through about 2 to 3 inches from the reducer, owing to the deflection of the sand leaving the large hose, passing through the reducer and then striking the nozzle at that point. This condition would suggest that a special, graduated coupling from hose to reducer be devised, so that the sand would pass through at a uniform rate without meeting a break, thus avoiding the deflection.

The force consists of a foreman, who regulates the valves controlling air and sand, two nozzle-men who direct the blast (these men had to wear goggles to protect their eyes), two men to dry the sand, attend to the fire and keep the tanks filled, and also one laborer, who assists the nozzle-men in handling the hose.

As the yard covered a large area and the steel was distributed all over it, it was a question whether it would be

more economical to have a portable blasting machine or to make it stationary and use the crane and traveler for the purpose of handling materials. It was finally decided to make the plant stationary and use the crane for collecting and subsequently piling the steel.

The material cleaned consists principally of bulb angle-columns, I-beams for wall-columns, roof I-beams, knee-braces, rivets, plate-girders, splice-plates, grillage-beams and angles.

The question of the advisability of cleaning the steel before it leaves the shops could well be taken up. Were the mill scale and dirt removed before the steel is painted, the protective coating given it at the shops would undoubtedly prove more effective in the prevention of corrosion than by the present methods.

Such an adjunct to the manufacturing plants, if properly laid out, could resolve itself into practically first cost. If automatic devices for drying the sand and then feeding it to the blast were devised, much labor and time would be saved. Still more, the nozzles of the blast could be in a fixed position, and a rolling table provided for the steel. An automatic device for spraying the paint on the steel might also prove an advantage.

In preparing this discussion the speaker had the assistance of Mr. R. S. Fowler, Junior Assistant Resident Engineer, who also furnished the data, photographs and drawings. The speaker's thanks are also due to Mr. J. J. Shannon, Inspector for the Rapid Transit Subway Construction Company, for useful suggestions.

THEODORE PASCHKE, M. Am. Soc. C. E.—Before giving any figures which can serve as a basis for comparison with those given by Mr. Lilly, as to the cost of cleaning some of the structural steel for the New York Rapid Transit Subway, as described by Mr. Belzner, it will be necessary to state briefly and as nearly as possible the actual conditions, rather adverse in some cases, under which the work had to be done.

When it became evident that the shop coat of paint had been practically destroyed by long exposure, and that it was necessary to arrest the destructive work of corrosion which had set in, the Subway Construction Company, in obedience to orders from the Rapid Transit Commission, assumed the responsibility of the work, and arranged with its sub-contractors on Sections Nos. 2 and 3 to perform the work of cleaning the steel and replacing the shop coat of paint, as an extra, at cost plus the usual percentage allowance customary in such cases. The sub-contractors for Section No. 2 (comprising the Elm street section) are the Degnon-McLean Contracting Company; for Section No. 3 (comprising Lafayette place and Fourth avenue) the Holbrook, Cabot & Daly Contracting Company. The work was done by them subject to the inspection of the engineers of the Rapid Transit Commission.

The work was started by hand cleaning, that is, by hammer, scraper and wire brush. This did not prove satisfactory, either in point of cost or in efficiency, and involved the sub-contractors in an almost continuous controversy with the inspectors. It was suggested that the sand-blast process be used, and in view of the fact that the sub-contractors had compressed-air pipes along the line of their work, thus facilitating the installation of such process, Mr. Deyo, Chief Engineer of the Subway Construction Company, readily assented.

On the Elm street section the steel to be cleaned was piled at various points along the street. Mr. Belzner has described the attempts made to locate the sand-blast at the various piles of steel. Thus, the operation of the blast had to be confined to one point and carried on during night hours. The steel had to be brought to the sand-blast and there manipulated by hand entirely. The arrangements for drying the sand were primitive, owing to the temporary conditions of the work. The first cost of installation of the blasts, their various removals and transfers from one point to another, was added to the cost, tending to increase this abnormally.

At the Forty-second street yard, where the Fourtn avenue steel was piled, the conditions were somewhat different. The yard is 200 feet wide and 700 feet long, and is provided with a network of tracks and a traveling crane with a flat car for the handling of the steel. Here a plant on a little more permanent basis was erected, and the steel handled and brought to it from the various points of the yard by the traveling crane. Although these conditions were

more favorable than on Elm street, they may be considered rather exceptional for such work.

In the work on Elm street and at the Forty-second street yard about 5,000 tons of steel have been cleaned by this process.

But all this steel was not cleaned over its entire surface; only about one-half being cleaned entirely, one-quarter had 75 per cent. of its surface cleaned, and on the other quarter about 50 per cent. of its surface underwent the sand-blast process, for the reason that on the remaining surface the shop coat was found to be in good condition.

In the case of the work at the Forty-second street yard, the total cost, including the repainting, amounted to from $3.50 to $6.50 per ton, the higher cost being due to the greater adversities experienced during the winter months. In the case of the work done on Elm street, the cost ranged about $1.50 per ton higher. It should be stated that the eight-hour basis for a day's work is in vogue throughout the subway work, and that the entire work of cleaning and painting had to be conducted in the open, exposed to all the vicissitudes of the weather, resulting often in the necessity of reblasting the steel before being able to paint it.

It would seem from these figures that, in the case under consideration, the use of the sand-blast did not result in any direct economy over hand cleaning. However, the results obtained were infinitely superior. The steel, after emerging from the sand-blast, presented a beautiful appearance, in fact, being fit to go into an electro-plating bath.

The experience had here with the usual customary shop coat as a protection for the steel against corrosion before erection seems to confirm Mr. Lilly's contention for the desirability of applying the sand-blast to structural steel at the works, after manufacture and before the application of the shop coat. Notwithstanding the high cost of the work performed in the present instance, which was due to exceptional and rather abnormal conditions, the speaker fully believes that the sand-blast process can be used at the works to advantage, and at a cost not exceeding that given by Mr. Lilly.

A. H. Sabin, Assoc. M. Soc. C. E.—Although the speaker has never actually conducted any sand-blast work, he believes that it was at his suggestion that the sand-blast was used upon the One Hundred and Fifty-fifth Street Viaduct some years ago. He has, however, been interested for years in this matter of the proper cleaning of structural steel before painting and can agree fully with what Mr. Lilly says about its great importance. It is a waste of money to buy even the best of paint and spend a large sum for labor in applying it to a rusty surface.

More than a hundred years ago, one of the great early English engineers—Smeaton—remarked that he had observed that if rust had once started on the surface of the iron, it made no difference what varnish or paint was applied to the surface, the rusting would continue to go on progressively under the paint. That conclusion has been reached by every man who has investigated the subject honestly and disinterestedly.

Mr. Paschke has stated when the steel had been cleaned with the sand-blast it was fit to go into an electro-plating bath. That is right. It will be observed that it is assumed that if a piece of metal is to be electro-plated it has to be clean, down to the surface of the metal; none of the oxide or scale must be left on the surface. It is equally true that to apply a vitreous enamel, such as on granite earthenware, etc., in the first place the surface of the metal must be obtained on which to put the enamel. All such ironwork is cleaned usually by pickling. To apply a varnish enamel, as in the case of a bicycle frame, it is absolutely necessary to do the same thing; otherwise the enamel, or the electro-plate, will come off in time, because the rate of expansion of the scale is always a little different from that of the iron, and in time the scale will loosen up.

Now, the speaker is a paint man, and has had an experience of a good many years. He believes that paint sticks on iron in exactly the same way that anything else does, and the conditions which favor the adhesion of other things favor the adhesion of paint. If it is necessary, if it is absolutely indispensable, as all agree, to have all these other coatings applied to the actual surface of the metal, and not to any scale or rust, or

anything of that sort, it is also desirable to apply paint directly on the iron.

There are plenty of people who think —no doubt many who think honestly— that the oil and paint will mix up with the iron rust and keep out the air, and in that way the corrosion will be stopped. The trouble with that theory is that the paint and varnish are not absolutely non-porous. If they were it would be all right. Neither is cement or concrete non-porous, and when the corrosion gets under way its action is very rapid. That is a chemical question which is not worth while discussing now, as it has been beaten over a good many times, and probably most of those who are interested in the subject are thoroughly familiar with the theory of the matter.

It is comparatively easy to keep iron free from rust when it is clean, but, after the rust has started, it is very difficult to stop it or to clean it away from the metal.

The speaker had hoped that this paper might bring out a discussion from somebody who had had experience in cleaning iron by dipping it in acids, or "pickling." Of course, that is not sand-blasting, but the result is what is desired. The speaker is not aware that, in this country, any structural metal-work has been cleaned by pickling, but a great deal has been cleaned in Europe, some of it many years ago, and it is being done now, with most excellent results. Of course, the result of a first-class job of pickling is just the same as the result of sand-blasting.

One of the advantages of the sand-blast, not mentioned by Mr. Lilly, is that it leaves the iron not only clean, but dry. The process of pickling leaves the surface of the iron wet, and it has to be dried. It would be difficult to apply the process of pickling to structural work in place, such as an erected bridge, or anything of that sort, but it would have been extremely interesting to have had an idea of the comparative cost of cleaning the steel for the rapid transit work by pickling as compared with the sand-blast.

There is probably a thousand times as much iron and steel cleaned by pickling as is cleaned by the sand-blast. There is an immense amount of it done. Those who are not familiar with the subject have no idea of the extent to which it is practiced, but, in this country, it has not been applied to structural steel.

There is a feature which did not appear in Mr. Snow's admirable discussion. Mr. Snow has really had a great deal of experience in the use of the sand-blast on bridges, and has told the speaker that, usually, he did not clean the whole of a bridge with the sand-blast, as that is regarded as rather expensive. Such parts of the bridge as are specially liable to corrosion are cleaned by the sand-blast, and other portions, which are not so subject to deterioration, are cleaned in a less thorough and less expensive manner, for the reason that those portions which are most liable to corrosion will, in spite of the greatest care that can be taken, probably rust out as rapidly as the other portions with somewhat less care, although, of course, a man who is sufficiently interested in the matter to do sand-blasting is not going to have any poor work done. This feature, however, is worth remembering.

It may be regarded in another way. If a man sets up a sand-blast plant to clean a bridge, and has all his apparatus and his gang of men to do it, and only cleans, say, one-quarter or one-third of the bridge, he cannot do that quarter or third of the bridge as cheaply per square foot as he could clean the whole bridge, so that the cost per square foot is a great deal higher than it would be if he were cleaning the whole work, and for that reason any figures that he gets must be taken with regard to that fact.

In reference to the possible danger of cutting away the iron: Mr. Lilly observed that it was immensely more difficult, and required a great deal more power, to remove a hard compact scale than to remove ordinary rust. Now, the difficulty of cutting away tough, hard steel is immensely greater than that of cutting away the hardest kind of rust, and the speaker was told— this was not his own experience—by the manager of the Wolff Bicycle Company, some years ago, when they were using the sand-blast for cleaning the frames of bicycles, that before they purchased their sand-blast apparatus they were apprehensive about cutting away the metal, because the tubing they used was very thin; and to test the matter they held a piece of tubing in the current from the sand-blast machine for twenty minutes continuously, and then, with a micrometer scale caliper, which would show a thousandth of an inch, were not able to find any diminution in the diameter of the tube. Consequently, they thought that they were safe in using

it; and if that is the case, there should not be very much apprehension as to cutting away the steel.

H. B. Seaman, M. Am. Soc. C. E.—There seems to be little to add to the discussion which has already taken place, except, possibly, to mention the dangers of the misuse of the sand-blast. It is undoubtedly a most efficient method of cleaning iron, especially where the rust is badly caked, or is in inaccessible corners and cannot be reached by hand; but where the rust is slight, and especially where surrounded by elastic paint, the excessive use of the sand-blast may prove more injurious than the rust which it removes. The sand-blast will remove the rust quickly, but if continued long enough to remove the elastic paint, which requires considerably more time, the parts which were rusted will be worn deep and pitted, and when the whole surface is bright and smooth, and acceptable to an enthusiastic inspector, more metallic iron may have been removed than would be the case after several ordinary coats of rust. Furthermore, the naked iron, as left by the sand-blast, will rust much more quickly than when the mill finish is left.

An illustration of the danger of overdoing the sand-blast occurred recently, under the supervision of an ardent, but well-meaning inspector. Four columns, which had been similarly exposed to the weather while stored in the same pile awaiting erection, were brought out and laid side by side to be cleaned by the sand-blast. After 3½ hours of the sand-blast two of these columns were stripped absolutely clean of rust and paint, and of all sign of the original mill surface; finished, in fact, clean enough for electroplating. The work could not have been done more thoroughly if performed in a laboratory for experimental purposes. The remaining two columns were then cleaned of rust and dirt, but all good paint was left on. This required 45 minutes, and the columns were left in better condition than the first two, at about one-fourth of the expense.

The theory that iron must be cleaned to a white surface before being painted does not seem tenable. The thin coat of black oxide formed after rolling is of itself a valuable protection, being the most permananet form of iron oxide, and even when the iron is tinted brown with rust it is not clear why the paint which would protect the iron from rusting will not in like manner prevent the rust from progressing, excepting, of course, where the rust is so thick as to prevent adhesion of the paint to the iron. Where the sand-blast is used it is necessary to paint at once to prevent corrosion.

Aside from the commercial or scientific value of sand-blasting, there is a very serious question of its effect upon the eyes and lungs of the operator. Its use in connection with bridge shops would seem not only objectionable on account of its disturbing effect upon the other operations, but, as already mentioned, would remove the black oxide of manufacture, which is its natural protection. Any scale which may be formed after rolling is quite thoroughly removed in punching and handling through the shops.

E. A. H. Tays, M. Am. Soc. C. E. (by letter).—The writer has noticed that the means of drying the sand, as described by Mr. Lilly, were very crude, and the idea suggested itself that they could be improved.

The following suggestions may be of service in enabling those of the profession engaged in that work to improve upon the present practice in that line:

Where temporary plants are required, a sheet-iron bed, 8 feet long, 4 feet wide, or wider, made hollow, about 4 inches high, or, with sufficient room for a 2-inch steam coil, or line, of pipes, set on a frame 3 feet high, would do the work; the steam coil being used to pass the exhaust steam through; or, the exhaust could be turned directly into the hollow bed. This bed can be made of the thinnest sheet or galvanized iron, and should have a 2-inch flange on the sides, but none at the ends; and it might be set with a slight fall, to facilitate drawing off the sand with a hoe or rake at the lower end.

In large stationary plants a cylindrical dryer, on the lines of the Howell-White roaster, or of the type of the ordinary ore-dryer used in dry-crushing mills, would seem to be just about the thing. It could be made of much lighter material than the ore-dryer and much smaller in size.

This dryer is a revolving cylinder, larger at one end than at the other, and is heated by wood or coal, the heat passing down the cylinder. The sand is fed into a hopper at the small end, and the revolutions of the cylinder, say five per minute, gradually pass it out at the other, thoroughly dried.

These observations may enable some of those who are working in this line to devise an economical as well as efficient sand-dryer; if so, the object of these remarks will have been attained.

George W. Lilly, Assoc. M. Am. Soc. C. E. (by letter).—Mr. A. H. Sabin has called attention to the fact that one of the great advantages of the use of the sand-blast is the dry condition of the metal after being cleaned by it. This is certainly a great advantage and essential to the best efficiency of the preservative paint. It is also true that, unless the paint is applied soon after the cleaning is done, moisture is likely to accumulate on the steel, especially if the atmosphere is nearly or quite saturated with moisture. It has been urged, therefore, that the paint should be spread within the shortest possible time after the cleaning is done, and in no case should any cleaned surface be permitted to remain over night without a coat of paint upon it. Some delay, say two or three hours, may be permitted when the atmosphere has only slight humidity. When the atmosphere is surcharged with humidity the moisture may gather on the steel immediately after it is cleaned. At such times no cleaning or painting should be done.

While, as Mr. Snow says, it may be considered no disadvantage to have some sand get into the raw paint, if it is to be subjected to the blast action of locomotives, yet screens are sometimes of advantage to prevent too large a quantity of sand getting into the paint in the buckets before it is applied to the steel. At times the wind may send large quantities of sand back to the painters and the paint become so filled with sand that it rolls under the brush and cannot be spread properly. It is not often found necessary, however, to use the screens between the nozzle-men and the painters.

The writer admits freely that neither the pan nor the hopper form of sand-dryer is scientific or highly efficient. A rotary dryer is, no doubt, a good form, where power is available and the exhaust steam may be utilized; but at Columbus, Ohio, the power was from 1,200 to 2,100 feet from the places where the cleaning was done. No doubt a better sand-dryer can be devised than any of those which have been used in the work done heretofore.

Mr. Seaman urges caution against the danger of extending the use of the sand-blast too far and cleaning steel which is already in good condition to receive the paint. The same thought was suggested in the paper, and it is certainly true that good judgment should be exercised. The intelligent application of the process in the cases where it is required to prepare the surface of the metal so that the paint, when applied, will adhere properly and give good protection against further corrosion is all that is contended for. For the reason that some of the paint was still good, some parts of the viaducts named in the paper were not sand-blasted down to the metal surface, but rust spots only were cleaned away. The parts where rust and corrosion have destroyed the paint, and where the paint is dead and disintegrating, should be cleaned thoroughly; and the sand-blast seems to be the best process for such purpose.

The black or magnetic oxide spoken of by Mr. Seaman is nearly all destroyed by the rusting of the metal before the shop work is completed, save, perhaps, where the thicker scale has formed. That all the mill scale is removed by the processes through which the steel passes in the shop is, the writer believes, putting the case rather too strong.

Mr. Fowler suggests permitting the metal to rust somewhat, in order to remove scale as far as possible, and then cleaning it thoroughly before painting. It will be observed, if a careful examination of old structures be made, that in many cases the mill scale has been covered with paint, and corrosion has attacked the steel and loosened the scale, making centers from which rust will extend.

The composition of mill scale, or, at least, of its characteristic, porous inner layer, makes it reasonable to expect just such results. Mill scale forms in two layers, the inner one being represented approximately by the formula $6\ Fe\ O + Fe_2\ O_3$, and, as stated, is very porous and brittle. The outer layer contains a larger but varying proportion of $Fe_2\ O_3$. The air and moisture contained in this porous scale tend to destroy the paint spread over it by starting corrosion. This scale is magnetic. A galvanic action is said to be set up around the edges, and corrosion commences there and afterward extends under the scale and outward under the paint. It is considered important, therefore, that the mill scale be removed by some efficient means before the first coat of paint is applied.

Pneumatic Tools and Appliances.*

Pneumatic tools, as generally understood, are essentially portable tools, and do not therefore directly enter into competition with fixed machines, excepting in this respect that it has now been found, in many instances, that it is far cheaper to do certain work in position rather than take it under a fixed machine, and to this extent competition exists, and even where the actual cost of the machining is greater with the penumatic tool, the ultimate saving is greater still on account of labor saved in handling the work, and in other ways.

Dealing with the various types of pneumatic tools under separate headings, hammers and rivetters will be considered first. The standard type of deck rivetter consists of a single-valve long-stroke hammer, attached by means of a simple clip to the end of a weighted rod, which is itself attached to a small two-wheeled truck.

The objects are:—(1) To bring into use for the purpose of deck-rivetting a hammer of standard type, which can be also used for other forms of rivetting when detached from the jig.

(2) To assist the operator, since the balance weights shown add to the pressure exerted by his own weight; and he can again increase this by placing his foot on the bar or weights.

(3) To obviate the necessity of his laying the hammer down on the deck and picking it up again for each operation after chipping off the rivet flush. This is provided for by suitable stops and lugs in the trolley, and also in the bar adjacent to the hammer.

One of the great desiderata in the use of pneumatic tools is to reduce multiplicity of types, and for this reason the above described arrangement helps to fulfill this object, since it converts an ordinary longstroke hammer into a deck-rivetter.

The valuable assistance obtained by the use of a pneumatic hammer for caulking and chipping are well-known, but it may be mentioned that in certain cases the cost of caulking has been reduced from 2½ d. to ½ d. per yard, and at the same time the operator has been able to earn 30 per cent. more wages on the modified piece-work rate.

Amongst a great bulk of reliable data now obtainable in respect to the saving effected by the use of pneumatic hammers, the following may be noted:—

(1) By the use of a long-stroke hammer on combustion-chamber work for marine boilers, the price of driving ¾-in. rivets in the seams has been reduced from 35/- per 100 rivets to 24/- per 100 rivets.

(2) A well-known boilermaker states that a long-stroke hammer is used for closing ⅞-in. diameter rivets in the back ends of flues of Lancashire boilers, which are tested to 175 lbs. per square inch, and the work is done by one man and a holder-up in two-thirds the time it takes two men and a holder-up by hand.

(3) The following is somewhat interesting.

COMPARISON OF HAND AND PNEUMATIC RIVETTING

Being controlled by the time limit allowed by the Boilermakers' Union.

How done	No. of Rivets Driven	No. of Rivetters	Holders-up	Boys	Time In Hours
Hand Rivetting.....	360	2	1	2	6
Pneumatic Rivetting	400	1	1	2	6

But even with this labor difficulty the saving in labor is not inconsiderable.

(4) A chipping hammer, when used for dressing the hardest kind of burr stones, will reduce the cost of dressing from 7 d. per square foot to 3 d. per square foot.

(5) A chipping hammer has proved very satisfactory when used for cutting doorways in a solid brick wall 2 ft. thick. The method employed was to cut a border line, or in other words one layer of brick out of the wall on each side of the doorway, and then cut one layer about every ten rows, after which it was possible to pry down the large pieces, and by this means one man was able to cut out two of these doorways in a day.

The advantages of compressed air as a motive force have, of course, been recognized for a long time, but the introduction of pneumatic tools has undoubtedly given its adoption a great impetus. In many shops it is frequently found that having installed an air-compressing plant other uses can be found for this form of energy

*Abstract of a paper by Mr. Ewart C. Amos, M. I. Mech. E., London, for the Manchester Assn. of Engineers, March, 1903.

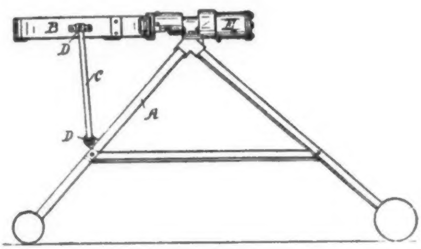
beyond driving what are generally known as pneumatic tools.

A novel form of screen shaker has recently been placed on the market and is meeting with great success.

It is the common practice in most foundries in this country to screen moulding sand by hand labor, a somewhat costly process when compared with what can be done with the machine which is about to be described.

The object for which this machine has been designed is to provide a simple, economical and efficient machine for screening sand, and reference to the accompanying drawing will at once indicate its simplicity.

It may first be mentioned that the air pressure necessary to operate this machine most economically is about 80 lbs. per square inch, which is the usual pressure adopted for driving portable pneumatic tools, and the quantity required is 12 cubic feet of free air per minute.



ELEVATION OF "HANNA" SCREEN SHAKER—TRIPOD FORM.

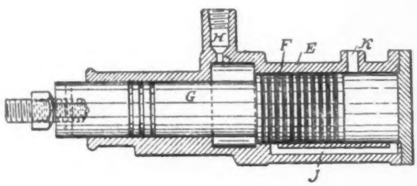
The machine is at present made in three designs. (1) As a tripod machine. (2) As a high frame machine for attachment to a wall, girder or similar support. (3) As a low frame machine for a similar method of attachment.

Referring to accompanying illustration, A is the tripod, B is the screen holder, into which an ordinary screen or riddle may be fixed.

The screen holder is supported directly upon two arms C-C, which are pivoted at the points D-D. In order to vibrate the screen holder, a cylinder, E, attached to the tripod, is provided with a reciprocating piston and piston rod, the latter being suitably connected to the screen holder so that the reciprocation of the said piston causes the screen holder to receive the necessary shaking motion.

In order to more fully understand the action of the compressed air upon the moving piston reference must be had to the other illustration, which shows the section of the cylinder and piston with the necessary parts. In this figure, E is the cylinder and F the piston, which is formed in one piece with the piston rod G. H is the inlet leading from the main air supply. J is a port leading to the back of the piston, and K the exhaust. The action of the compressed air in causing a reciprocation of the piston is as follows:—

In the drawing the piston is shown towards the front end of the cylinder, and on the admission of air at H, will force the piston and screener backwards. When the piston has travelled sufficiently back to uncover the port J, air will travel to the back of the piston and will counteract the backward motion of the piston and drive it with the screen holder forwards,



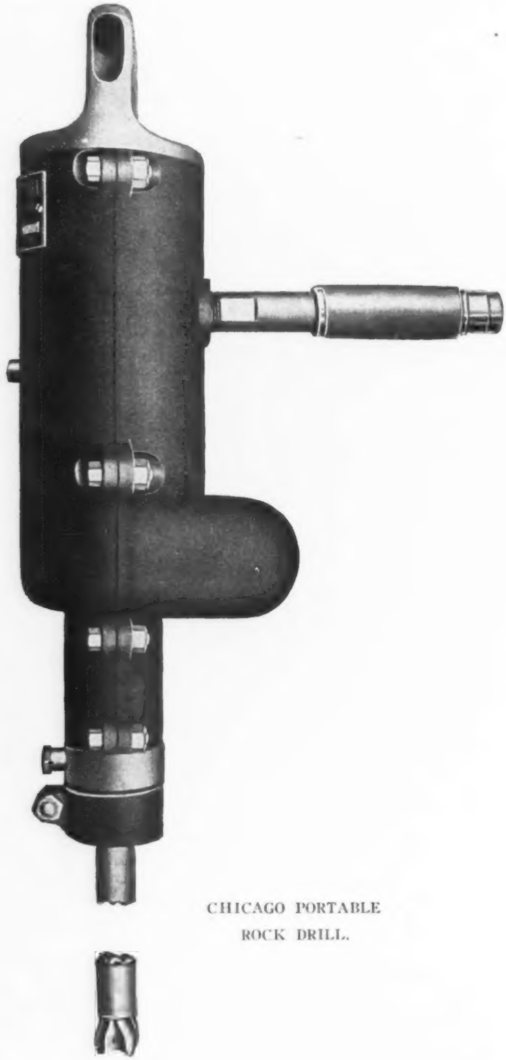
SECTION SHOWING PISTON AND CYLINDER WITH PORTS OF "HANNA" SCREEN SHAKER.

the exhaust taking place through the port K. By this arrangement it will be seen that the compressed air is caused to act constantly against the front end of the piston and intermittently on a superior area against the rear end of the piston, and in that way an automatic and constant reciprocation of the piston is obtained without the use of any valve.

Amongst the advantages offered by such a device are the simplicity and portability of the arrangement. The holder carries an 18-inch diameter screen, and screens can be changed in the fraction of a minute. When using a ½-inch-mesh riddle, the machine will shake all the sand that two men will care to shovel; and in actual practice in every day work in a foundry it has been shown that a laborer is able to riddle as much sand in 2½ minutes as a moulder and a laborer can do in half

an hour. It is essentially portable, the tripod machine weighing only 100 lbs., whilst the post machine weighs only 50 lbs.

hour for depreciation and repairs, plus 7½ d. per hour for labor, we have as a total 2¼ d. + 1¼ d. + 7½ d. = 11 d. per hour, and the machine will have riddled



CHICAGO PORTABLE ROCK DRILL.

As already stated, the machine requires 12 cubic feet of free air per minute, or say 720 feet per hour, which will cost 2½ d. per hour, and add to this 1¼ d. per

as much sand in one hour as a man would do in five hours. The cost of his wages alone during this time would be 3/-, so that the saving effected shows at least 2/1.

The post machine can of course be used equally well as a fixed machine, and in this case steam instead of compressed air may be used to drive it when compressed air is not available.

Another development in the use of compressed air, is a portable rock drill, as shown on pages 2428 and 2430.

It has been designed to take the place of the ordinary rock drill for certain classes of work, and owing to its lightness and extreme portability (since it requires no mounting whatever) it has proved itself to be highly efficient and to have achieved this object.

Referring to the sectional views, it may be stated that compressed air causes the moving piston to reciprocate at a high speed, as in an ordinary pneumatic chipping hammer, and this in turn strikes the end of the bit, giving the desired percussive action to it. The drill bit is enveloped in a tube, and by means of a blast of air running through it, clears the hole of all obstruction. This arrangement is extremely valuable in cases where the class of rock being bored does not require the use of water.

For drilling "block-holes" in quarry work for "plug and feather" work, as carried out in cutting stone to desired dimensions (by drilling a number of small holes in line previous to splitting) and in many other classes of work, the saving effected in both time and labor over the old method of feeding the drill by means of a screw and adjusting the tripod in position is shown to be very considerable.

The mechanism is so simple and free from complication, and the machine is so easy to handle, that unskilled labor can be employed to use it. The machine complete, weighs only 50 lbs., requires 42 cubic feet of free air per minute, and will do the same work in 1-20th the time taken by hand. As an example of actual work done, a lad of 18 years has drilled 120 holes ½ in. diameter × 9 in. deep in granite in 6 hours.

In certain cases it is desirable that not only shall the tools be portable in the ordinary sense, *i. e.*, within the limit of the flexible air mains, but also that the whole plant, including the air compressor receivers, etc., shall be capable of being easily moved about. This is particularly the case in railway bridge repairs and similar classes of work.

Many such plants are now in use and are doing splendid work. It will be noted that the whole of the machinery is contained in the permanent way covered wagon, and this can be put in immediate operation wherever it may be placed, as it is entirely self-contained and portable. The plant consists of (1) 12 H. P. horizontal type boiler with necessary fittings, injector, etc. (2) a steam-driven air compressor, having a capacity of 134 cubic feet of free air per minute. (3) a water tank and pipes for supply of water used for cooling the air cylinder, the tank also serving as a feed-water tank to boiler. (4) air receiver. (5) flexible hose and connections. (6) small bench and vice. (7) eight pneumatic tools.

Such a plant costs approximately £670 exclusive of the truck, and is capable of operating six to eight pneumatic tools simultaneously.

Wherever greater portability is required, *i. e.*, independence of the railway track, and when it is desired to take it along the roadway, the same arrangement is used, but the truck is made lighter and ordinary road wheels provided. Semi-portability may be obtained by simply bolting the compressor down to timber or girder foundations, as is frequently done by gas-holder manufacturers and other contractors who may require the plant at work in one particular place for a few weeks, more or less.

Again, where neither steam-power or electric-current are available, the compressor may be conveniently driven by an oil engine. In this case it is good practice to place the oil and air cylinder together on the same crank-shaft, the whole being mounted together with the air receiver on a road truck.

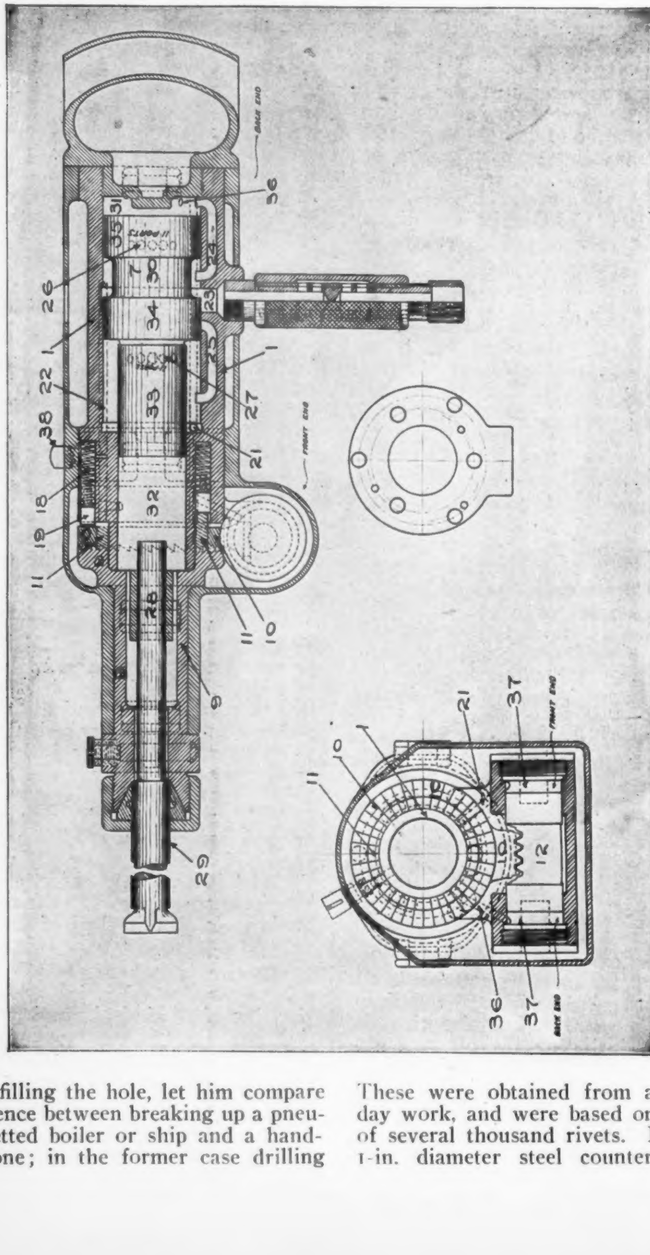
Last year Mr. E. C. Amos visited the United States, and a day was spent at the shipbuilding yards of Messrs. William Cramp & Sons, on the Delaware river, Philadelphia, with the object of investigating the progress made in the use of pneumatic tools on this class of work.

There are in use in this yard some 700 to 800 pneumatic tools of various description, a large number of which are devoted to rivetting of all kinds, including flush rivetting.

Messrs. Cramps' experience in the use of pneumatic tools is entirely favorable to their universal adoption for flush rivetting of all kinds, both on the ground of economy and also because the holes are

better filled than with hand-driven rivets. In addition to this it is far less laborious for the operator.

If anyone doubts the statement about the rivet filling the hole, let him compare the difference between breaking up a pneumatic-rivetted boiler or ship and a hand-rivetted one; in the former case drilling out the rivets is generally the quicker way. Some actual figures given to the author at Messrs. Cramps' may be interesting to the members of this Association.



SECTIONAL VIEWS OF CHICAGO PORTABLE MULE DRILL.

These were obtained from actual every-day work, and were based on the driving of several thousand rivets. For instance, 1-in. diameter steel countersunk rivets,

costing 4 dollars per hundred by hand rivetting, cost 3½ dollars when driven by pneumatic rivetter. Perhaps 2/- per 100 may not appear a great saving, but it must be borne in mind that there are a good many hundred rivets in a ship, and what is more important, the work done was far superior, in addition to which the operators earn more and are better satisfied and less fatigued. Another figure may be given, ¾-in. rivets in water-tight work, costing 2·75 dollars per hundred by hand rivetting, were done by the machine for 1·25 dollars, which must be admitted is a very great saving.

It may be interesting to state that in a large installation such as that in Messrs. Cramps' yard, the cost of air supply may be taken at about 8 to 10 cents per day per tool.

As to the time taken, a gang will close about 250 1-in. dia. flush rivets in the hull of a ship per day.

In respect to economy, which Messrs. Cramps have secured, it must be noted that it is the extensive application of jigs and appliances in connection with pneumatic tools that has made pneumatic rivetting so popular, and these appliances can now be readily obtained in this country when desired.

In addition to the rivetter and drill, the pneumatic chipping hammer finds much work in Messrs. Cramps' yard for cutting out manholes, etc., in addition to ordinary chipping, and generally the pneumatic tool is brought into action wherever possible.

Pneumatic tools have now passed the stage of experiment and, moreover, the standard machines are more or less familiar to those in the engineering profession, so that specialization becomes the order in this as in most branches of machinery.

Regarding the various data given in respect of the work done by pneumatic tools it might appear at first sight that the various results enumerated, somewhat conflict with one another, but it must be remembered (1) That they are the result of actual practice, and to that extent are interesting. (2) That outside conditions, not perhaps notified when giving the results referred to, have produced a variation in time and cost on what would appear to be quite similar jobs. (3) That ¾-in. rivets or any other size that may be named, take a longer or shorter time to close, according to their position and shape of head, and the same remark applies also to every class of work whether drilling, rivetting, or chipping, etc. In other words, that local conditions have to be taken into account when making a comparison, and finally it is especially necessary to take into account the human factor, which plays a very considerable part even when handling pneumatic tools.

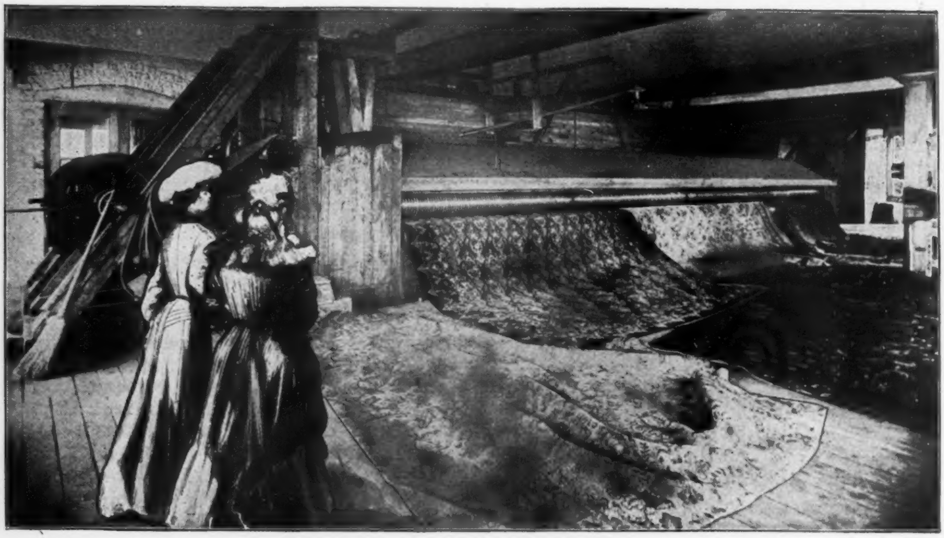
The American Pneumatic Carpet Cleaning Company.

In light, clean, airy rooms, necessarily large, belonging to The American Pneumatic Carpet Cleaning Company, 536 West Twenty-third street, New York City, carpets and rugs are run through 40 foot machines, without a single fold, thereby preventing any possible chance of damage by creasing, and, as the goods are passed through by an automatic chain-carrier arrangement, every inch thereof is brushed from above and beneath by rapidly revolving brushes, releasing every particle of dust or dirt, and then, by the application of large volumes of compressed air, forced through the crevices of the goods from above and beneath, every vestige of dust, moth eggs, etc., are blown out and instantly taken away by a powerful suction device, which carries the objectionable matter into the furnace, under the boilers.

These machines are so arranged that both the air pressure and the revolving brushes can be adjusted, as the case may require, for heavy Axminster and Wilton carpets or fine, delicate fabrics.

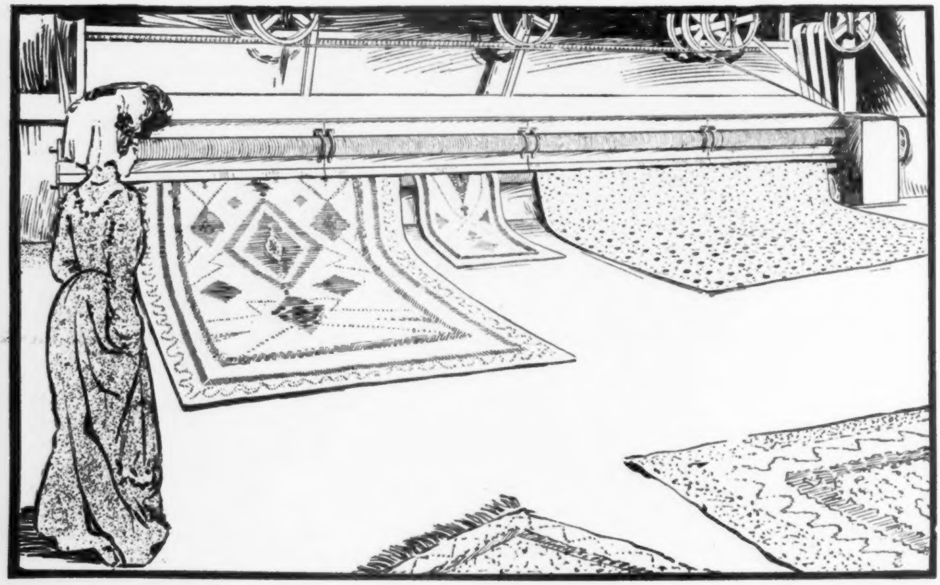
Any size of carpet or rug can be handled on these 40-foot machines. Then, if soot and smoke are found to still adhere to the surface, the carpet is tacked to the floor in the airy shampooing-room and quickly, lightly "shampooed" without wetting a particle of the warp, just cleansing the smoky surface.

A glimpse into this company's plants reveals an equipment thoroughly modern, from basement to roof. In the former are located two immense 150 horse-power boilers, which supply power for operating the machine and supply steam to the air compressor. The latter, also in the basement, consists of two powerful cylinders and pistons capable of compressing air into a large tank or reservoir at a pressure of



CARPETS PASSING INTO MACHINE.

As carpets pass through the machine, they are brushed by a series of revolving brushes, and then great volumes of compressed air are blown directly through every fibre, removing all foreign matter.



CARPETS COMING OUT OF MACHINE AS CLEAN AS WHEN NEW.

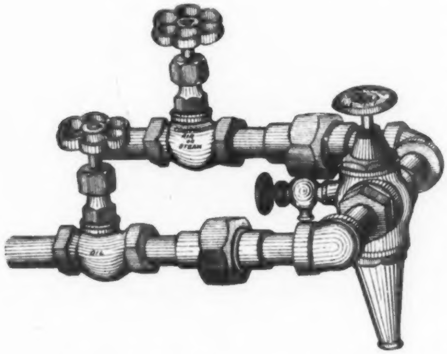
one hundred pounds to the square inch. One of these compressors alone was installed at a total cost of $8,000. Compressors of large capacity are required to maintain a lesser, but even, working pressure of air from the hundreds of jets which are in operation during the cleaning process.

Owing to the space required for inspecting and folding large carpets, one entire floor is devoted to the cleansing process and inspection, the two rooms being separate. Both are high, light, clean and airy.

Upon still another floor is the Oriental room, where Oriental rugs and all kinds of fine, delicate or rare rugs, tapestries and draperies are carefully repaired by experts. Often entire collections are carefully renovated, all breaks or tears repaired and returned fresh, clean and strong.

Moran Liquid Fuel Burner.

The oil burner herewith illustrated will heat from 22 to 25 square feet of grate



MORAN LIQUID FUEL BURNER.

surface and will equal a ton of good coal with 100 gallons of oil. There are no coal or ashes to handle, and the use of this device saves labor and gives dry steam. This appliance can be attached to all kinds of furnaces for melting steel, nickel, iron, copper, brass, babbit, lead or any other material requiring furnace heat. It can also be used with good results for annealing furnaces, muffles or any furnace designed for annealing process, and can be attached to angle or plate furnaces used in boiler or marine construction. The oil burners are also affixed to rivet forges, portable or stationary, while their usefulness for working on a ship's side or hole, for heating bent or fractured plates, is apparent.

This patent oil burner is placed on the market by James Moran, 47 Horatio street, New York, N. Y.

Various Uses of the Atmosphere.

Railways would find it difficult to get on without the use of compressed air. Boring plates of steel in the locomotive works is almost everywhere accomplished by the use of compressed air machines. The Great Eastern works at Stratford, England, have a complete outfit of pneumatic borers. Up-to-date signaling entirely depends on the use of air. The London and Southwestern has partially adopted the pneumatic signaling system. The points and signals are moved by compressed air, conveyed underground in pipes, and soon wires will be no more seen. The saving of time, labor, space and capital is enormous. The Southwestern is beginning to install the system at Basingstoke, and will gradually extend it over the rest of its line.

For cleaning, dusting and sweeping purposes compressed air far excels any broom or duster ever made. For carpets and cushions it is particularly useful. A pipe flattened at the end to the shape of a spade is used, and air, rushing with great force through the narrow slit, carries off every particle of dust. One man can do the work of three armed with brooms, while there is an equally immense saving in wear and tear, for air, of course, does not destroy a fabric as bristles do. Clothes and uniforms are also brushed in the same fashion.

Another industry in which air is ousting bristles is that of painting. Very soon the paint brush will disappear before the paint spraying machine. For covering large surfaces the economy effected by the paint spray is almost miraculous. By way of a test of what was possible, a man using a compressed air painter recently covered 46,000 square feet of surface with an even coat of paint in six and a half hours. A smaller air-brush has been made for the use of artists. The patent for this latter machine brought over $15,000.

At the Agricultural Hall, Islington, there

was recently shown a pneumatic milking machine. The apparatus works by means of pulsators, and effects a saving of more than 50 per cent. of the time and labor, beside insuring that the milk shall be fresh and uncontaminated. The cows soon get used to it, and prefer the machine to the hand method.

For the ringing of heavy bells and of chimes, no power has been found to surpass compressed air. At the Church of Saint Germain l'Auxerrios, in Paris, which was finished in the year 1878, is an orchestral chime, said to be the largest in the world. There are forty-four bells in the set, and until a compressed air plant was installed it was found impossible successfully to ring them. One man plays them now as easily as if they were an organ. A keyboard is beneath his hand, and when he presses a key, an electric trigger opens a valve in the steeple, which admits compressed air to a piston connected with a clapper which strikes the bell.—From *London Answers.*

Rix Small Compressed Air Locomotives.

This small compressed air locomotive (Fig. 1) has been designed for running on a 16 per cent. grade, using a cog-geared track. Owing to the fact that it was necessary to keep the diameter of the wheels the same diameter as the cog gear, the wheels were made quite small, so that it does not make as handsome a looking arrangement as it might otherwise have done. The whole machine was designed for an inexpensive proposition.

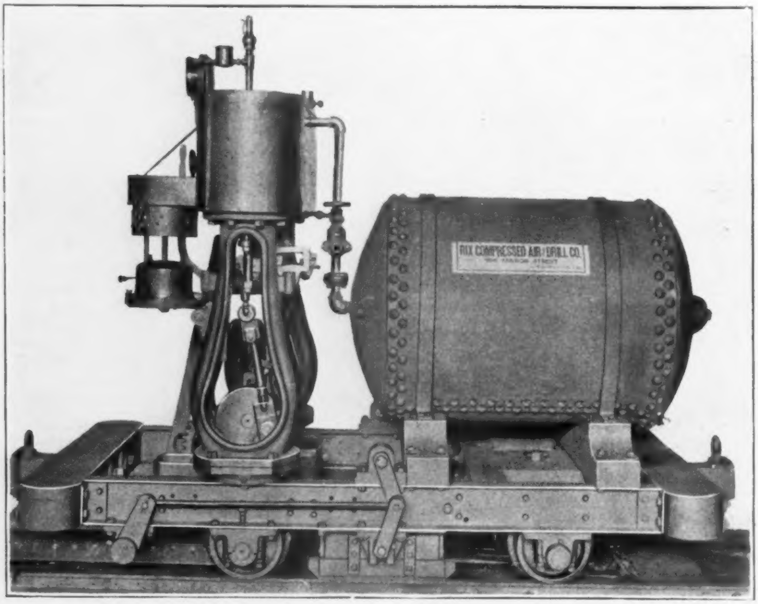


FIG. 1—RIX SMALL COMPRESSED AIR LOCOMOTIVE.

The engines are compound, the high pressure cylinder being 4 in. in diameter, and the low pressure cylinder 8 in. in diameter; both of these 6 in. stroke, calculated to run 300 R. P. M. and the engines are geared four to one to the main driving cog gear. The initial pressure is 120 lbs., the receiver being charged at 600 lbs. to the square inch. You will note that the cylinders are enclosed in a casing. This casing is made of double thick-

ness of sheet iron with asbestos packing between them. By referring to Fig. 2, you will note that each cylinder in the casing is surrounded by copper coils marked E for the high pressure cylinder and K for the low pressure cylinder. Between the cylinders is a receiver. There is also a throttle valve, C, and the bi-pass valve, G, also arranged in the heated chamber. In front of one of the frames of the engine is located a primus coal-oil burner having four burners attached. This supplies heat to the casing. There is a hole for the heated air to escape at the bottom of the low pressure cylinder so that there is a continual circulation of heated air passing through the casing and out. and the chamber as near as can be estimated is at about four to five hundred degrees Fah. The cylinders and valve

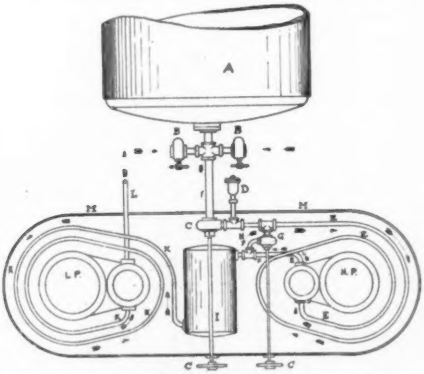


FIG. 2—PART PLAN VIEW RIX COMPRESSED AIR LOCOMOTIVE.

chests of both engines, being enclosed in the casing, are kept at that temperature continually, which is the particular and desirable feature about this motor. The air admitted through the main throttle passes around the copper coil valves and into the high pressure cylinder and is exhausted from there through the pipe F into the receiver I and passes through the copper coil K into the valve which is in the low pressure cylinder. After being used in the cylinder it is exhausted into the atmosphere.

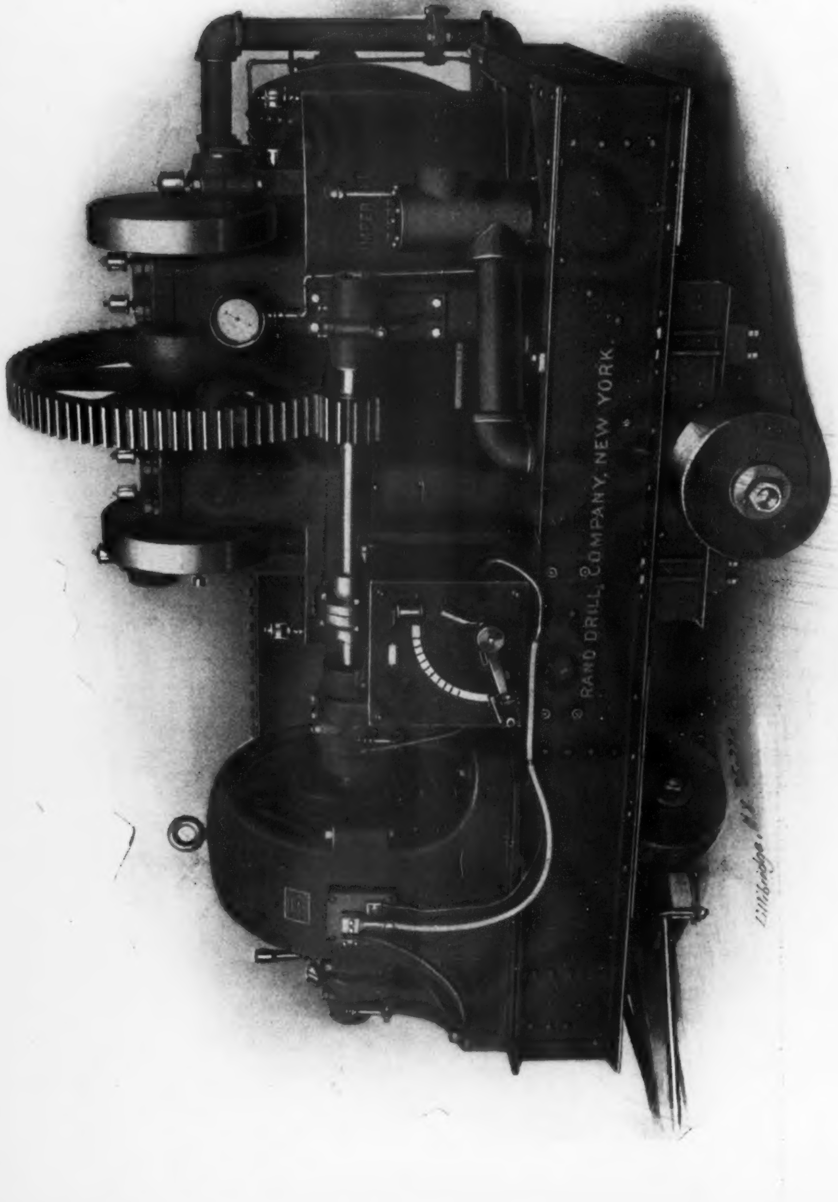
There is no reducing valve at all between the air in the high pressure receiver and the main throttle valve. There is no difficulty about freezing, because the throttle valve, being placed in the heated chamber, does not permit it. There is a bi-pass, G, which admits high pressure air into the receiver, I, if it would be required to develope at any particular time more than normal power and also to start the engines if the crank on the high pressure cylinder were not in a favorable position for starting.

It is claimed that this system of reheating is a thorough one, as well as being extremely simple and taking very little oil to do it. It is estimated that a H. P. will be generated by this process not to exceed seven cubic feet of free air per minute, compressed to 100 lbs. The great difficulty heretofore has been (in engines which require reheating and which were intermittent in their service) that the cylinders and valve chests become cool before the engine is put in service again and much power is lost thereby. In fact in hoisting engines before the compressed air can heat up the cylinder and valve chest, the hoisting is finished, and this action is repeated over and over again, and amounts to using air at a very slightly increased temperature above that of the atmosphere.

This device is the invention of Mr. E. A. Rix, president of the Rix Compressed Air and Drill Co., San Francisco, Cal., to whom we are indebted for the description.

Rand Portable Air Compressor.

The Rand Drill Company have recently built for the Jones & Laughlin Company, of Pittsburg, Pa., a new design of portable air compressor. This machine has two 12 x 12 vertical single acting plunger cylinders water jacketed and has a capacity of 275 cubic feet of free air per minute, the air pressure being 100 to 110 pounds. It is driven by a 50 h. p. Westinghouse motor, direct current, 220 volts, with starting rheostat, a raw-hide pinion on the motor shaft meshing with the cut gear of the compressor. The air receiver is 28 inches diameter by 8 feet in length. The outfit is mounted compactly on a wrought iron frame with heavy axles, wheels and shaft for moving it with horses from place to place. The Rand Drill Co., 128 Broadway, makes this design in sizes from 16 cubic feet to 320 cubic feet free air per minute.—*Iron Trade Review.*



RAND PORTABLE AIR COMPRESSOR.

Tullahoma, Tennessee, Water and Light Plant.*

The Tullahoma installation is located between Nashville and Chattanooga, Tenn., perhaps the first case on record in the South of a small municipality's supplying its citizens with water and light, with the source of power at such distance from the town as to require what is ordinarily termed a "high-voltage transmission line."

In designing the plant, it was decided to secure the water supply from deep wells, if possible to do so. A large spring, within about one-half mile of the station, might have been used, but was rejected in favor of wells, mainly because of its proximity to the cemetery, besides being subject to overflows at times. An 8-in. well was drilled within 100 feet of the station, and, after passing through the upper, or surface water, which has heretofore supplied the town the drill struck rock at a depth of about 100 feet. Into this the wrought-iron casing was tightly driven, in order to cut off all the surface supply. At 120 feet a strong stream was struck, which rose immediately to within 45 feet of the surface; and when tested with a 4-in. cylinder pump, it yielded the capacity of the pump —viz., 100 gallons per minute, with a reduction in head of only 6 feet. It was then decided that two such wells, chambered out to a total depth of 200 feet to allow proper submergence for the air-lift pipes, would yield a sufficient quantity of water to supply the town. The second well was placed about 80 feet from the first well, and struck the same vein at practically the same depth; and it proved to be even a better well than the first one. It was noticed, however, that the two wells were not far enough apart to prevent one being slightly affected while the other was being pumped.

For pumping the wells into a surface reservoir, the air-lift system was adopted as being best suited to the existing conditions; and a 12 in. x 12 in. duplex, single-stage compressor, arranged for belting to one of the 50-horse-power motors, was installed in the station. The suction pipe from this machine was taken outside the building, and the 4½ in. discharge was carried to a 36 in. x 10 ft. receiver, which was also located within the building. The air was then led to the two wells through proper-sized pipes, and the discharge from the wells was conducted to the reservoir through separate 5 in. galvanized-iron, screw-joint pipes. In piping the wells, 190 feet of 5-in. galvanized pipe was placed in each well, the same being suspended from a 5-in. long-sweep tee, to which the discharge to the reservoir was connected. Within the 5-in. pipe in each well a 2-in. galvanized iron pipe extended to within 5 feet of the bottom of the 5-in. pipe, and was fitted at the end with a perforated brass nozzle, which discharged the air spirally upward through 30¼-in. holes, or jets. After the installation was completed the wells were tested, and yielded continuously at the rate of 25,000 gallons per hour, the water being of excellent quality. Continued use of the wells since completion has increased the yield to a perceptible extent.

The wells discharge into a covered circular brick reservoir, or basin, of 80,000 gallons capacity—the diameter being 30 feet; the depth, 15 feet. From this the water is delivered to the elevated tank and distribution system by means of a vertical triplex pump of 750,000 gallons capacity per 24 hours, directly connected by double-reduction gears, to a 50-horse power induction motor.

* Abstract from a paper by Mr. Granbery Jackson for the Proceedings of the Engineering Assn. of the South, Feb. 12, 1903.

British House-Cleaning Device.

Frank W. Mahin, Consul at Nottingham, England, under date of April 25, 1903, writes in the "Advance Sheets of Consular Reports" as follows:

"The sidewalk in front of a large furnishing house in this city is daily blocked by crowds of people watching through the windows the working of a new cleaning device. The first inquiry of the surprised and admiring spectator usually is, 'Is that an American idea?'

"So far as is known here, there is nothing like this cleaner outside of England—not even in America—for the firm (Smart & Brown) exhibiting it informs me that it recently received from a Chicago dry-goods house an inquiry for a cleaning device on this same general principle.

"The system was invented by Mr. H. C. Booth, of London, and last year was taken over by a company which experimented with it in various metropolitan hotels, theatres, and other public places. Lately it has been tested in railway carriages, and now, its practicability being assured, agencies are being established throughout the British provinces.

"The apparatus consists, in the first place, of a machine composed of a 2 to 4 horse power motor—oil or electric—and an air pump, serving to maintain an 'exhaust' of several pounds to the square inch. The machine may be portable, on wheels, or stationary. To it is attached a filter—the dust receptacle—a tightly closed metallic vessel, with capacity of a peck or more. From the filter extends a 1½-inch rubber hose, which may be of any desired length up to about 700 feet. The hose terminates in a 'cleaner' or 'renovator,' which is a tube flattened out at the end into a kind of long slit. This is rubbed over the carpet or up and down the cloth covering of settees or chairs, from which it quickly sucks all the dust, extracting it not only from the surface, but also from the body of the substance and from underneath it—the underfelt being thus cleaned. Not a particle of dust can be detected if the carpet is then beaten. Indeed, in an experiment made in this city with a carpet returned as clean from a power beater, a considerable amount of dust was extracted by the vacuum process. The severe test of sprinkling a carpet with flour and thoroughly rubbing it in has been made, the vacuum cleaner removing every particle of the flour.

"No dust is raised in a room. All is sucked through the hose into the filter, whence it is removed and hygienically disposed of—analysis showing that it is composed of many deleterious substances. The pile and color of a carpet are restored by this process, and it is claimed that there is no injurious effect whatever.

"In a similar way, walls may be cleaned of dust, the cleaner being a brush of horseshoe shape, with an exhaust tube in the center.

"In hotels, theatres, large business houses, and the like, it is proposed to install permanent stationary plants, so that cleaning can take place daily, thus practically abolishing sweeping. Such a plant would be in the basement, with an iron pipe of small diameter leading to fixed points on each floor. At these points flexible hose would be attached, and the plant would be operated, collecting the dust in the basement. No skilled operators are required. Railroad and street cars, vehicles, and ships' cabins and saloons could all be cleaned daily by stationary plants.

"To clean residences, the portable machine can be placed in the yard or street and the hose extended into the different rooms. It is stated that the carpets, tapestry, upholstered furniture, mattresses, and bed clothing can all be cleansed of dust in a day, one man cleaning six or eight rooms. There are half a dozen different renovators attachable to the hose, adapted for carpets, chairs, walls, or bedding, as the case may be.

"Nothing is said about cleaning clothing, but there is no perceptible reason why the process would not serve that purpose.

"The sanitary feature of this mode of cleaning, in that it removes dust from the house and destroys it, is dwelt upon. The *London Lancet* considers the system of sufficient importance to particularly describe and approve it.

"The machines and apparatus are at present only leased and in no case sold by the cleaner company."

New York, May 28, 1903.

Editor of Compressed Air:

Dear Sir:—You probably have received copies of the "Advanced Sheets of Consular Reports," such as we enclose herewith, but we cannot restrain the desire to send you these for fear you might not have seen them. It certainly seems remarkable that our consul at Nottingham should know nothing about a device that has been repeatedly illustrated in your pages.

M. T. Richardson Co.

Compressed Air Motors for Gathering Cars in Coal Mines.*

While the coal-mining practice, in regard to hauling on main roads, has advanced very rapidly in recent years by means of compressed air, electricity and ropes, that of gathering from rooms or working-places has remained almost stationary. Few large mines are without some method of mechanical haulage on

*By Mr. Beverley S. Randolph, Frostburg, Md., at the Albany meeting for the Transactions of the American Institute of Mining Engineers, February, 1903.

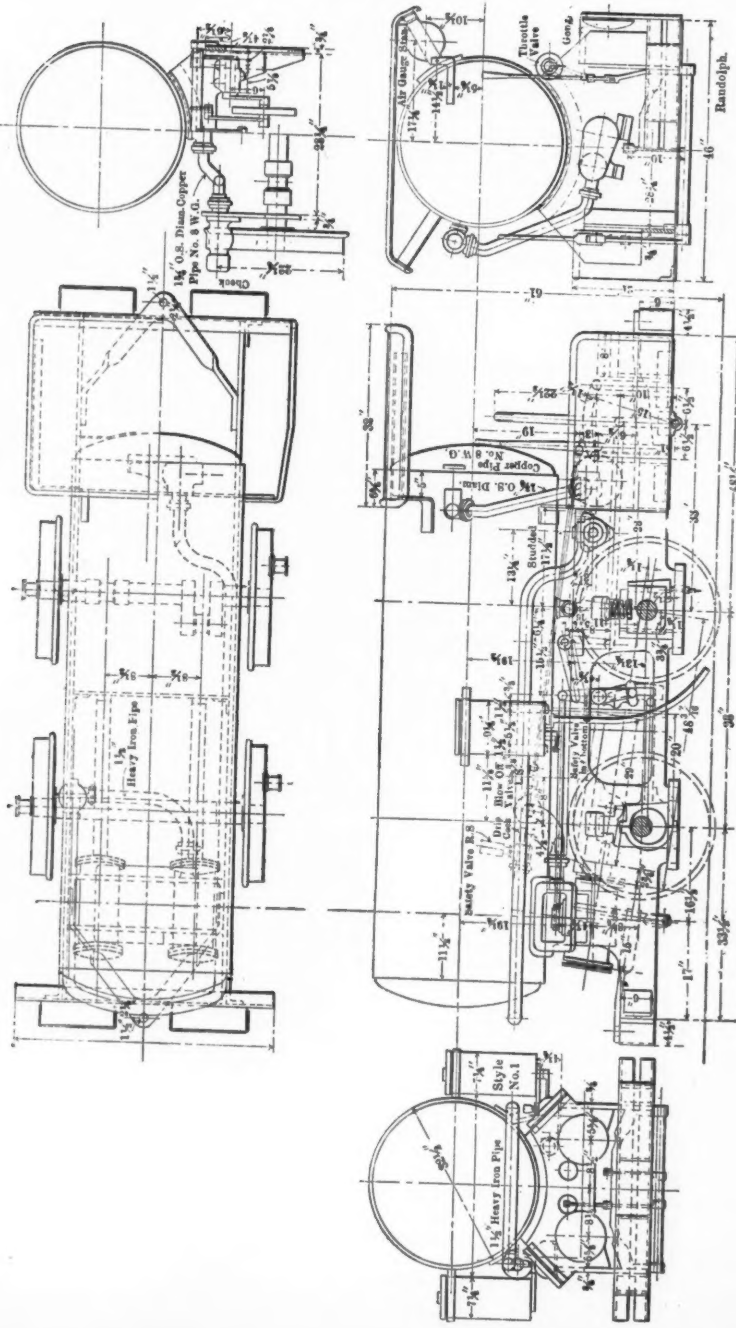


FIG. I.—MOTOR USED BY THE CONSOLIDATION COAL COMPANY.

main roads, but the gathering from working-places is still done almost entirely by means of animals or men.

An effort to improve this have been made recently by the Consolidation Coal Company, under the direction of the writer, at its mines in the Georges Creek Region. The seam worked is the Pittsburg Bed, known locally as the "Big Vein." It is from 8 to 12 feet thick. Immediately overlying the coal there is from 5 to 6 feet of "rashings," consisting of thin alternating beds of shale and coal, which disintegrate rapidly on exposure to the air, and makes a very treacherous roof.

Rooms are driven 12 to 15 feet wide, with a single track close to one side. A line of posts is placed just far enough from this side to leave a clear space for the mine-car with a driver at the brake. This brings the post not far from the middle of the cross-bar, and provides more effectual support than if placed at the end. The tracks in these rooms are usually of 4 in. x 4 in. oak scantling, though of late years, owing to the advance in the price of lumber and the reduction in steel rails, more of the latter are being used. This track is laid by the miner. His pay for the work is included in the price per ton for mining. It is, therefore, as a rule, unskillfully and often carelessly laid, and cannot be relied upon to carry safely any weight materially greater than the loaded mine-car.

Compressed air was already in use on the main roads, driving motors weighing 30,000 pounds each, and which are used to haul mine-cars that have been assembled from the rooms, bringing them to the foot of a slope, from where they are hauled to daylight by means of a rope.

At the suggestion of the writer, the Baldwin Locomotive Works designed a motor, having the dimensions and general character shown in accompanying drawing (Fig. 1), and guaranteed not to weigh more than 8,000 pounds when charged. Loaded mine-cars frequently weigh 7,000 pounds gross, and their outside dimensions are then practically the same as the motor just mentioned.

Five of these machines were placed in the Company's Ocean No. 3 mine (Hoffman), displacing a number of mules, but leaving 19 still working. This opportunity was embraced to make a close comparison between the two methods of gathering.

The mules working in the North Heading and the South Heading deliver their cars directly to the rope on the slope. The other mule-routes deliver to the heavy motors mentioned above, as do all the motor-routes. The mules used weigh from 1,200 to 1,400 pounds, and are the best obtainable. Mine-cars weigh 1,600 pounds, and carry an average of 2.4 long tons.

The following table shows the work performed by the mules during a period of 18¾ working days in the month of December, 1902:

Route	Cars Moved	Average Haul	Constant	Tons Moved 1000 ft.
South heading.....	1119	2900 ft	$\frac{2.4}{1000}$	7788.24
North "	268	1300 "	"	836.16
1st Cross..........	1629	2100 "	"	8210.16
2d Cross..........	3042	1100 "	"	8030.88
3d Cross..........	747	400 "	"	717.12
Total.....................................				25582.56

This represents a total of 339 days' work for one mule.

The company's accounts show a cost of $1.15 per day for each day worked by a mule, including expense of replacing worn-out animals. Drivers are paid $1.98, and there is one with each mule. This makes a cost of $3.13 per day for each day worked by a mule. The cost per ton hauled 1,000 feet would therefore be

$$\frac{339 \times \$3.13}{25{,}582.56} = 4.15 \text{ cents.}$$

For the work of the motors during the same time we have:

Route	Cars Moved	Average Haul	Constant	Tons Moved 1000 ft.
Tippens...........	1122	2300 ft.	$\frac{2.4}{1000}$	6193.44
Scobies	1073	2050 "	"	5279.16
1st Klondyke......	1147	1835 "	"	5046.80
2d "	1032	1800 "	"	4458.24
3d "	1147	1865 "	"	5138.56
4th "	114	1992 "	"	544.92
Total.....................................				26661.12

This work was done by the five small motors operated by compressed air, working a total of 94 days.

This plant is supplied with steam by a battery of boilers, which also supplies steam to the large pumps. The plant con-

sists of the following items, with their approximate first cost:

One straight-line Norwalk air-compressor, 18 and 28 compound steam, 18½, 13½ and 6½ three-stage air, 30-in. stroke	$ 5,300
5,600 feet of 5-inch pipe	5,600
3,100 feet of 2½-inch pipe	1,700
1,000 feet of 1½-inch pipe	300
2 motors, 30,000 lbs. each	6,000
5 motors, 8,000 lbs. each	10,000
Estimated proportion of boilers	1,000
Installation	4,000
	$33,900

Allowing $3,000 per year for interest and depreciation, to be earned in three hundred working days, would justify a charge of $10 per day from this source against the entire plant.

This same compressor also drives the large motors mentioned above, which weigh 30,000 lbs. each (60,000 lbs. for the two); the five small machines weigh 8,000 lbs. each (40,000 lbs. for the five). Dividing the general expenses according to the weight would result in four-tenths being charged against the small motors.

These general expenses may be summed up as follows per day:

Coal, 4 tons @ $1	$ 4.00
Fireman	2.00
Mechanic in charge of compressor	2.50
Interest and depreciation	10.00
	$18.50

The daily cost of operation of the five small motors would then be

5 Motormen at $2.67	$13.35
5 Brakemen at $2.03	10.15
General expenses, $18.50 x .4	7.40
Repairs and oil	3.00
	$33.78

Dividing this among the five machines would give $6.78 per day for each machine, and the cost per ton moved 1,000 feet would be

$$\frac{6.78 \times 94}{26,661.12} = 2.44 \text{ cents.}$$

In the matter of continuity of service, the motors show a great advantage. A broken-down motor can usually be repaired over night, while an injured mule can only be replaced by a new one that must usually be broken and inured to the work before he is thoroughly efficient, entailing loss of time and output in each case.

In the actual placing of cars in the workings, the motor has little or no advantage over the mule. After the train is made up, its higher speed and larger load place the mule at a great disadvantage.

The showing of the motors may, therefore, be expected to be better with long hauls than with short.

Owing to the fact that it is the practice in this mine to send the same motor or mule on different routes, depending on where miners may be loading coal, it is impracticable to present any discussion of this feature from the data at hand.

Ajax Drill Steel Sharpener.

While rock drills have been formerly sharpened by hand, the Ajax Drill Steel Sharpener, recently placed on the market, opens a new field which will be of decided interest to mine operators, contractors and others engaged in work where a number of rock drills are used. The Ajax Sharpener is an apparatus for sharpening drill steels by power instead of by hand. Its operation is such that the bits are formed in the same manner as when hand forged at a materially reduced cost and a greatly increased speed. This machine includes a vertical hammer, consisting of a modified air drill with anvil, dies and suitable support and guides which side set and forge the wings, and a similar hammer set horizontally and provided with a second set of guides, dies and a clamp which does the dolly work and forges up the face of the bit. The parts and general arrangement of the apparatus are shown in the accompanying illustration.

While strong claims are made for this machine they seem to be substantiated by the practical trials given; its capacity is about 1,200 steels in twenty-four hours, the time for each steel ranging from 30 seconds to one mintue. Bits sharpened in this way, it is claimed, are more regular and better than those sharpened by hand, and it is even said by those using the Ajax Sharpener that the machine-forged bits will put down from 100 to 300 per cent. more holes than those sharpened by hand.

At the United Verde and Homestake mines one machine in each case now does the work formerly required by twelve men. The air required to sharpen 600 drills in ten hours is about one-fifth as much as

required to run one 3-inch drill underground. As an illustration of the saving which is claimed for this machine, it is pointed out that the United Verde Mines sharpened 500 steels in seven hours and 140 in seventy-five minutes. At the Homestake Mines 300 steels were sharpened in five hours. In both instances the machines were operated by green hands with only two weeks' experience.

AJAX DRILL STEEL SHARPENER.

A Pneumatic Revolving Crane.

The accompanying drawing shows a special type of pneumatic revolving crane made by the Garry Iron & Steel Co., Cleveland, O., which differs somewhat from the standard types made by this company in having an adjustable boom and counterweight. These standard cranes are divided into two classes, B and C, similar in design, but of different capacities. Form B has a capacity of 1,000 lbs., 7 ft. reach, 12 ft. 6 in. hook lift and height from rail to top of boom of 9 ft. 2 in. Form C cranes are of larger capacity, 2,000 lbs. to 10,000 lbs., with a standard reach of 12 ft., standard hook lift 12 ft. 6 in., and height from rail to top of boom of 15 ft. 6 in. Both sizes are mounted on a heavy car and arranged for standard track gage. The gage may be altered to suit requirements or the cranes may be mounted on a special hand truck, as shown in the drawing, for convenience in moving about in storerooms, warehouses or platforms.

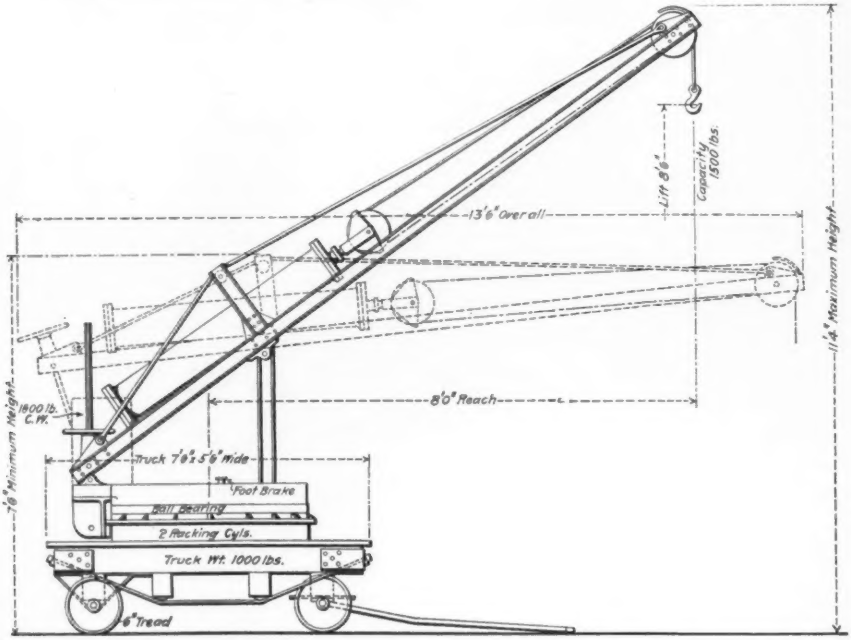
Unless specially ordered the crane cars are equipped with a set of rail clamps to prevent tipping when lifting the load. On special orders cranes are built with a counter balance on the turn-table as in the crane illustrated. This obviates the use of rail clamps. The cars are of extra heavy design and when built as a hand truck are fitted with four wide tread wheels. The crane base is bolted directly to the car and has a machined ball race on its upper face which contains 193 ground steel balls.

In the standard types, the bottom of the base is machined to receive the cylinder

rack, guides, pivot and stop. The projecting ring on the under side of the base is machined for rollers and brake. The brake bracket is attached to the turn-table and hoisting cylinder and has secured to it an air cylinder and rollers actuated by a foot valve convenient to the operator. The hoisting cylinder is securely fastened to the turn-table and brake bracket and is additionally supported on the top of the turn-table by the vertical struts. The air is applied in such a way as to permit matic crane with a trolley which racks in

and out on the boom, giving four applications of power.

These cranes are particularly adapted to loading canal boats, freight cars, for coaling locomotives and all purposes requiring heavy lifting. In and about railroad shops and yards and on freight platforms they have found a large field. Each crane is tested to its full capacity before leaving the works, and the workmanship and material is the best possible.—*Railroad Gazette.*



PNEUMATIC REVOLVING CRANE.

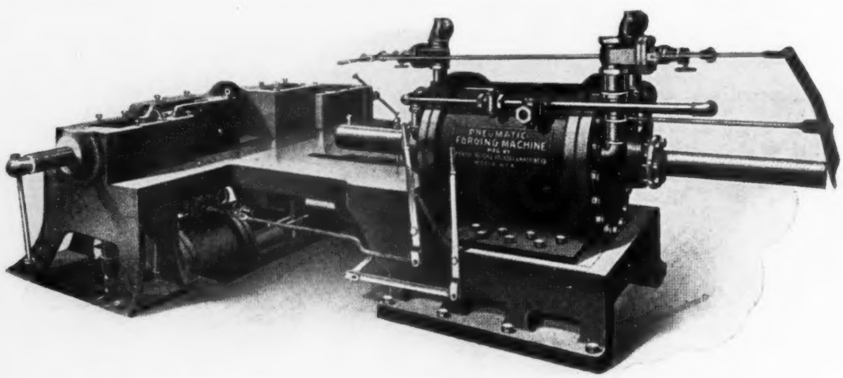
the operator to handle the crane for all movements without changing his position. Heavy channels stiffened by top truss rods are used for the boom. Ordinarily the hoisting cable has one turn about the main sheave for hook lifts of 12 ft. or more, but this may be modified to suit requirements.

The standard type of crane can be furnished with traversing motor on the car or with hand traversing arrangement if desired. This company also makes a pneu-

Pneumatic Forging Machine.

We show herewith a half-tone of the Pneumatic Forging Machine, or "*mechanical blacksmith,*" manufactured by the Featherstone Foundry and Machine Co., Chicago, Ill. These machines have met with extraordinary success wherever installed; their range of usefulness is practically unlimited, and to a modern, well-equipped blacksmith shop they are indispensible.

The Pneumatic Forging Machine has a T-shaped frame, or bed-plate, and is operated by two cylinders, one forming and one adjustable die. On the longer arm of the bed-plate is mounted the upper cylinder, the piston of which transmits the power to the forming die. At either side of the shorter arms are the die-holding forms, which can be set to open and close at any desired distance between them, and one of which is operated by a lever connecting with the piston rod of the lower cylinder. The speed with which the blows can be struck is limited only by the rapidity with which a man can operate an angle-cock, as the return of the pistons is effected by means of compressed air; while the capacity of the machine for turning out work is restricted only by the amount of material that can be heated and handled.



PNEUMATIC FORGING MACHINE.

By reference to the half-tone it will be seen that the piston rods pass through both ends of the cylinders, and on the driving end of the upper piston rod is a socket for receiving the stems of the male dies.

The great advantage possessed by the Pneumatic Forging Machine over all other forging machines, or bulldozers, lies in the fact that from one to three minutes only is required to change the dies necessary in the most complicated work, and in every case this can be effected before the metal in the furnace can be brought to the proper heat for working. This feature permits of the manufacture of a great many different shapes a day. It would be impossible to do this with the ordinary bulldozer on account of the length of time required to change the dies.

The die-blocks are of a rectangular form and are provided with interchangeable rollers of the two inner corners, which come in contact with the metal as it is forced into the dies. One of these die-blocks is connected to the lower cylinder, and is capable of being used as pneumatic hammer, which greatly increases the range of usefulness of the machine, and the amount of work performed, at the same time permitting work of a superior quality to be produced. The construction of the dies is made very simple by this arrangement, the dies for nearly all of the difficult operations being simply lifted in and out of the forms.

The hammer piston and die-holding piston can be operated either separately or in conjunction with each other, while the force of the blow or static pressure in either case can be controlled at will. These adjustments are accomplished by the opening or closing of the cut-out cocks in the line of piping in front of which the operator stands. To strike a blow with the hammer the lever-valve just over the back of the cylinder is opened. This admits air to the back side of the cylinder. The cut-out cocks in the smaller lines of piping having been set properly, the air in the cylinder now passes around behind the opposite side of the piston, and it is forced back to the beginning of the stroke. When the piston arrives at the end of its return stroke the extension of the piston rod on the back end strikes the trip lever, which

in its turn opens the exhaust. The operation of the piston actuating the movable die-holding jaw is made independent or contingent upon this procedure by turning the angle-cocks in the large and small lines of piping which run to this cylinder.

Eighty-five per cent. of the forgings for locomotives, and probably ninety-five per cent. of those for cars, can be turned out on this machine without the aid of a blacksmith's hammer. The terrific blow, in combination with the squeeze which follows, is one of the special features possessed by this machine not found in any other of like character. Rod straps, draw-bar yokes, frame buckles, pipe clamps, valve yokes, truck spring hangers, passenger car equalizers, and the like, of any dimensions may be made from the same dies by merely applying plates to the faces of the dies of such thickness as will furnish the desired sizes. By placing liners over the face of the die, in forming pipe clamps, it is possible to forge from twenty to twenty-five different sizes of clamps in one minute, while a locomotive main rod strap weighing 236 pounds has been forged in forty-seven seconds, and a valve yoke forged complete in five minutes. Turnbuckles are forged and welded in two operations, smoke arch braces with one blow, and the thimble for rope hoists or switch ropes is bent and grooved in a single operation.

In forming needle beam washers and safety straps for body truss rods, the die-blocks are screwed toward the center of the machine and form the sides of the female die, the proper shaped male die attached to the piston rod bending the heated bar around the loosely journaled rollers placed in the front corners of the form, and forcing it between the dies. In work with four bends the method of procedure is the same, except that the rollers are replaced by filling blocks which give square shoulders to the die forms. In forming draw-bar yokes a two-part die is inserted between the faces of the die-holders, which is firmly held by the vice-like action, and the bar operated on in three different positions. Riveting and welding operations can be simply performed on the machine by the use of either hammer.

The saving effected by the use of the Pneumatic Forging Machine is made obvious by the two following illustrations: A blacksmith and two helpers will average two valve yokes per day; using the Pneumatic Forging Machine the same three men can turn out from ten to fifteen valve yokes daily. A blacksmith and two helpers require about two hours to forge a 250-pound locomotive rod strap; using the Pneumatic Forging Machine the same gang can bend and shape eight to ten straps in two hours. The same saving can be effected in the manufacture of an unlimited number of forgings.

These machines are designed for a working pressure of 125 pounds, and are built in three sizes.

Pumping Water by Compressed Air.

Pumping water by compressed air has many advantages over the old methods, inasmuch as the natural sources of water supply are not conveniently located with respect to the desired point of delivery or to the motive power.

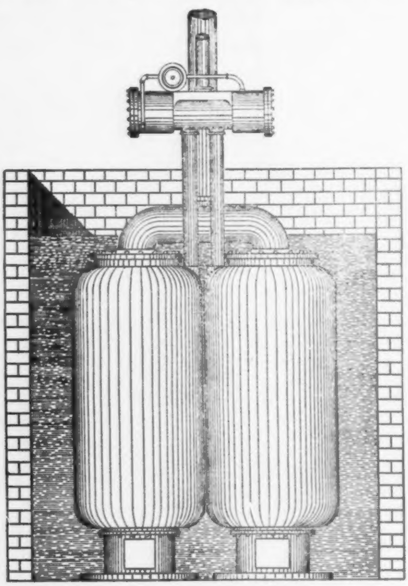
There has recently been placed on the market a pump which utilizes compressed air from any convenient source of generation for elevating modern and large quantities of air. This pump has been used by manufacturers, for draining mines and for domestic water supplies in which water is forced from wells, springs or cisterns to any height or distance required. In this last method, the water is aerated and purified and in no way contaminated or injured.

It consists of one or two water chambers, adapted to be submerged at the source of water supply, and an automatic air-valve located above the water and connected with the chambers by air pipes as shown. The automatic air-valve directs compressed air to and from the water chambers, from which the water is alternately discharged by the direct action or displacement of compressed air, without the intervention of pistons or other complicated mechanism. By the use of two cylinders a perfectly steady discharge of water is obtained. The automatic air-valve is by far the most important part of the apparatus.

It is actuated solely by compressed air applied on differential surfaces, and is entirely independent of the water chambers, in which there are no floats or other valve-actuating mechanism whatever. The automatic air-valve is constructed of cast iron with brass cylinder lining, containing differential piston-valves.

The piston-valves are kept pressure-tight by the use of pliable packings, which are held out by brass tension rings. These packings, being above the water, only come in contact with compressed air, which during compression, absorbs sufficient oil to thoroughly lubricate the packings.

It is claimed that these packings will remain perfectly tight for several years, under ordinary conditions. They are the



COMPRESSED AIR WATER PUMP.

only wearing parts of the valve and can be easily and cheaply renewed, if necessary. The water chambers are mounted upon a base casting, which contains screened annular water-inlet openings and foot-valves of large area.

A branch discharge pipe, having extensions, with discharge valves thereon, near the bottom of the chambers, forms a connection for the top of the chambers, as shown. The water chambers may be of any shape or size or of any material to conform to the requirements and conditions of the liquids pumped.

This pump is manufactured by H. L. Frost, Bristol, Tennessee, to whom we are indebted for the foregoing description and cut.

Book Review.

"Modern Machine Shop Tools." Their Construction, Operation and Manipulation, including both Hand and Machine Tools. By Mr. William H. Van Dervoort, M. E. 552 pages, size 6x9 in. Publishers, Norman W. Henley & Co., 132 Nassau street, New York City.

It is a complete, practical treatise of the most modern machine shop tools made to-day, showing their construction, operation and capacity, and giving speeds at which tools can be run. The chapters pertaining to the shape of tools, their proper cutting position and the steel they are made of, would be appreciated by mechanics. It is a complete course of instruction for students and apprentices, and a ready book of reference to a mechanic, foreman, superintendent or office. It shows at once the possibilities of a machine or tool or the proper method of doing work, and is a valuable book to have. The general arrangement and the index of the book are complete, so that any subject can be quickly found.

Notes.

In a plant recently installed in the South by the Pneumatic Engineering Company, 128 Broadway, New York, the air-lift system pumps nine million gallons of water per day from four 10-inch wells.

The Lunkenheimer Co., Cincinnati, has increased its foundry output 50 per cent. to meet the demand for its brass and iron steam specialties. A number of new machine tools are being installed as fast as they can be obtained.

The Sullivan Machinery Company will open a new branch office at the Missouri Trust Building, St. Louis, Mo. Mr. P. F. Jarvis, who has made St. Louis his headquarters for the past two years, will be the manager of the new office.

Where compressed air is available a badly pounding pump can be cushioned to any extent desired by connecting the air chamber of the pump with the compressed air line and regulating the amount of cushioning with a globe valve in the air line.

Bion J. Arnold is testing at Lansing, Mich., the electro-pneumatic system of air storage of electric power described by him in a paper read before the American Institute of Electrical Engineers last June, and reprinted in COMPRESSED AIR, August, 1902.

The Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio, have issued catalogue No. 53, descriptive of their pumps, water heaters, compressed air machinery, etc. It contains over 100 handsomely printed pages, with many superb illustrations of their various types of machinery.

The air compressors in the railroad shops at Oakland Cal., compress air for all the yards and station signals besides providing the supply for pneumatic hammers and other shop tools. It takes 1,000 cubic feet of free air per minute to keep up the supply. Pneumatic tools are greatly in evidence in these shops.

A more elaborate use of compressed air was inaugurated in the West Eighth street freight yards of the Central Railroad of New Jersey Sunday, June 14, when all the switches in that yard, heretofore operated by hand, were controlled by a single operator in the tower with the aid of a pneumatic interlocking system.

The Norwich Compressed Air Company of Norwich, Conn., which has recently equipped a plant in that city, has filed with the secretary of state a certificate of organization. The company has elected these officers: President, John A. Inslee; vice-president, H. H. Gallup; secretary, J. T. Fanning, and treasurer, W. J. Hanford.

The Rand Drill Company, through their pneumatic tool department, report the recent sales of many large complete air plants, including their new "Imperial" Pneumatic Hammers and Piston Air Drills. Plans are now being drawn for an extensive enlargement of the Rand Drill Company works to meet these increased demands.

Chicago has been considering the pneumatic tube question. The council recently granted a franchise to the Chicago Postal Pneumatic Tube Co. for establishing a system in the city. The other bidders then appealed to Mayor Carter H. Harrison, who refused to affix his signature to it, until a fair test of the different systems can be made and passed upon by engineering experts.

Horace P. Marshall & Co., Leeds, England, have recently installed, as agents of the Consolidated Pneumatic Tool Company, Limited, a compound steam-driven air compressor of 1710 cubic feet capacity at the shipyard of Messrs. Vickers, Sons and Maxim, Limited, Barrow-in-Furness, this being the fourth and largest compressor put down by them in that department for pneumatic labor-saving tools.

Mr. A. M. Baird has been appointed to represent the Falls Hollow Staybolt Company, in Topeka, Kansas, and vicinity. Mr. Baird was formerly boiler maker at Santa Fe shops, Topeka, and has been in the employ of several of the leading western railroads in the capacity of foreman boiler maker. He is the inventor of several compressed air tools, among them the celebrated Baird staybolt nipper.

The Chicago Pneumatic Tool Company have just issued two special circulars illustrating various types of their pneumatic appliances, and containing several views showing the tools at work. Something new is shown in the special applications of the "Jam Riveters," their use in cleaning crown sheets on locomotives and expanding boiler tubes on locomotives with a sectional tube expander is pointed out. A novel yoke attachment for the Boyer Drill is also shown.

The value of an air receiver does not lie in the volume of air stored. It is in no sense a reservoir. The function of an air receiver is to convert the intermittent supply of air from the air compressor into a steady stream. A pulsating current of air through an air pipe would cause an enormous loss by friction besides racing the pipe and loosening the couplings. A parallel may be drawn between the fly wheel of an engine and an air receiver. Their functions are practically identical.

Rock drills are not efficient machines when operated under low pressures. This is true commercially or mechanically. Under such conditions a rock drill will work very slowly, but the labor required will be the same as if it were working at full pressure. The cost per foot of hole is therefore increased. Mechanically speaking the friction of the machine is practically a constant whatever the load. Hence with low pressures the ratio of friction to useful effective load is greater than with high air pressures.

The coal-mining industry of Westphalia, Germany, continues to be seriously hindered by the prevalence of sickness among the miners. The disease is caused by an internal parasite, and has spread so widely that it has become almost universal. It is estimated that 20,000 workers are suffering from it, some pits having as many as 90 per cent. of their staffs disabled. All attempted remedies have hitherto failed, and the disease for the present is baffling the local authorities.

In a recent discussion upon the use of pick coal-cutting machines objections were raised to this class of cutter because the vibration of the machine was said to have proved detrimental to the health of the miners. This statement was combatted and one of the debaters said: "We hear a good deal about machines shaking runners to pieces, but there is no foundation for such statements. When a man becomes proficient, a light, loose grip of the machine, and a small pressure on the foot block enables the runner to handle the machine at will, where the cutting is not exceedingly hard."

A company in England is introducing a vacuum process for cleaning railway coaches. In operation it is used with a wide nozzle in the same manner as pneumatic pressure is used in this country—the difference lying in that the dust is drawn into the nozzle and through piping to be deposited in a receptacle instead of being merely blown into the air whence it settles down again. The exhaust is derived from portable plants operated by electric motor or gas engines at small terminals and from larger, permanent plants at the larger terminals. The vacuum process is much more satisfactory in many respects than the pressure process and is well worth the investigation of officials concerned with coach cleaning.

In a recent paper by Mr. Henry S. Spackman, he says:

"I have had no personal experience with the pumping of marl from the dredge to the mill, but understand that the most successful device is a double cylinder with compressed air, the marl itself acting as a piston, the device consisting of two tanks which are alternately filled and emptied. After the tank is filled, the compressed air is turned on and the contents forced into the pipe line."

He also refers to compressed air as being substituted for the old mechanical agitators in a number of mills, and calls attention to the considerable advantage thus gained by its use.

The Annual Convention of the American Railway Master Mechanics' Association will be held at Saratoga, N. Y., on June 24th to 26th inclusive. Immediately following, on June 29th to July 1st, inclusive, the Master Car Builders' Association will hold their annual Convention at the same place. The place of meeting has been changed from Mackinaw Island to Saratoga.

While compressed air will incidentally be mentioned in the various discussions, the only subject which deals directly with it is that of "Steam and Air Line Connections," which is announced as one of the subjects for discussion at the Master Car Builders' meeting.

The Tabor Mfg. Co., of Philadelphia, have arranged with The Draper Co., of Hopedale, Mass., for the manufacture and sale of the Hand-Rammed Molding Machines, which the latter firm have been building for their own use.

The Draper Co. have had probably the longest experience in molding by machinery of any firm in this country, consequently their machines represent the result of years of experimenting, including the trying of many other makes now on the market. At present they have in operation in their Hopedale plant several hundred of these machines. They are light, cheap, on wheels and do not require power to operate them.

This arrangement represents a very important move in the molding machine business.

The Philadelphia Pneumatic Tool Co. have employed Mr. J. F. Ahearn, formerly with the Scully Steel & Iron Co., to assist Mr. A. G. Hollingshead, Western Sales Manager for the Philadelphia Company. This company have also appointed Mr. H. B. Griner, late Assistant Manager of the Chicago Pneumatic Tool Co., to a position in the main office of the Philadelphia Pneumatic Tool Co.

This company report orders for chipping hammers, riveters and drills from the Craig Shipbuilding Co., Toledo, Willamette Iron & Steel Co., Portland, Oregon, Kewanee Boiler Works, United Gas Improvement Co., J. D. Connell Iron Works, New Orleans, Chandler & Taylor Co., Allis-Chalmers Co., and others.

A new device has been patented in England, which is an improvement on the apparatus for forcing sewage by compressed air. This consists of a simple mechanical arrangement to reduce the friction upon the valve spindles employed in opening and closing the valves for the admission and exhaust of compressed air. The spindles are made independent and are coupled by a special coupling, which will allow for inaccurate fitting and also the wearing out of truth. Half coupling is secured to the end of each valve spindle of the plug valve, and a similar half coupling to the ends of the spindle moved by the float. The half couplings engage each other by means of studs made firm in one-half coupling but working loose in a slot on the other, therefore any slight difference in accuracy has clearance without affecting the movement required.

The Le Clear Mfg. Company, 107 Chambers street, New York, are putting on the market the pneumatic door check and spring. It is especially designed for use on screen doors or very light inside doors. It will go into a space of 3½ inches, and thus can easily be operated between the outer door and the screen door. It is held back in action, holding the door open when it has passed the center. The spring power is strongest when the door is in a closed position, holding the door tightly closed, and gradually decreasing in power as the door is opened. The air pressure is regulated by a thumb screw. The device can be used on either right or left hand doors by reversing it, without extra attachments. The manufacturers refer to the device as simple in construction and easily applied. It is furnished in regular bronze finish, bronze metal highly polished, and in bronze metal, antique finish. It is also made in special finishes to order.

The turntable of the Duluth & Iron Range Ry., at Two Harbors, Mich., has been equipped with a pneumatic operating motor. This application is very simple and yet the work of turning the heaviest engines is performed with the greatest ease. The arrangement consists of a double cylinder engine mounted between the wheels at one end of the table and operated by a single lever extending up through the table deck. The engine is connected by a universal joint on either side, to shafts which rotate the table wheels through appropriate mitre gears.

In view of the fact that a gasolene turntable equipment costs approximately somewhat in excess of $1,000, and an electric equipment costs in the neighborhood of $1,150, a disposition to obtain the advantage, without the usual cost, through the adoption of a plain arrangement of engines operated by air has been tried in several places. At least three different plans have been shown during the past year in the *Railway and Engineering Review*.

Mr. W. V. Turner, air-brake inspector, and Mr. Geo. R. Henderson, superintendent of motive power of the Santa Fe System, have patented an air-brake device, which makes it possible to recharge air brakes on a train while the brakes are set. The advantages claimed for it are stated as follows: "It will do away with the creeping due to the leakage of the train line. It maintains a uniform pressure on all of the reservoirs on the train, thus preventing the possibility of a train breaking in two. It allows the brakes to be recharged while set, thus making it utterly impossible for a train on a grade to start and run away while the brakes are being reset. The best brakes now in use have to be recharged every few minutes. The Henderson-Turner brake can be set on a train and the train will remain on the

grade for a month if desired. In addition to the advantages of safety, the new brake is very economical, employing but two-thirds as much air as the best brakes now in use and allowing a great saving in pumps."

Some interesting and valuable particulars regarding turbine air compressors have been announced in a lecture by the Hon. C. L. Parsons, the inventor of the steam marine turbine. The Parsons Company is now making a specialty of this apparatus, and some very remarkable results in contrast with air compressing plants have been attained. In one case a compressor driven by an electric motor, supplying air at a pressure of 2 pounds per square inch, delivered 3,500 cubic feet per minute, and the efficiency of the plant as measured by the ratio of air horse power to electric horse power was 61 per cent. With the Roots blower, which was previously used, the efficiency measured was only 41 per cent. In another similar plant in work at a foundry near Leeds, England, 11,300 cubic feet of free air is supplied per minute at 3 pounds pressure. In this instance the air turbine is driven by a steam turbine running at 5,200 revolutions per minute, and the air horse power is 61 per cent. of that theoretically obtainable from the steam used

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The following extract is taken from a circular recently published by the Chicago Pneumatic Tool Co., of Chicago: "As the air taken into the compressor generally contains some particles of grit and dust it is almost impossible to prevent this foreign matter from entering into the working parts of the hammer, causing the ports to become clogged and rendering it inoperative. The use of a poor grade or heavy-bodied oil will also cause the same trouble. A good plan to follow in such cases is to clean by using benzine freely through the throttle handle. This dislodges all foreign matter and cuts the thick oil which can then be removed by blowing the air through the hammer. It is an excellent plan to submerge the hammer occasionally over night in a bath of kerosene and then blow out under pressure the following morning, and lubricate with a good quality of light machine oil. Where the air is unusually laden with foreign matter we would recommend the use of strainers or filters to be attached to the tool or placed in the supply pipe as the case may be."

The United States Consul at Genoa reports on a recent visit which he made to the Simplon in order to ascertain the character and progress of the vast work on the railway there, which means so much for the future of Genoa. He finds he was misinformed when writing an earlier report as to the nature of the obstacles encountered on the south side of the tunnel and as to the fears that it might prove necessary to change the course of the line. His examination on the spot removed all doubts on this head, for work is proceeding rapidly and uninterruptedly on both sides of the Alps; about 4,000 workmen are employed in the tunnel, and no fewer than 6,000 on the Italian section of the line between Isella, at the mouth of the tunnel, and Arona, the present terminus of the line running north from Milan. It is certain now that the work will be completed by the estimated date—July 1, 1905—for nearly two-thirds of the tunnel was finished by July last, and the worst obstacles have been met and overcome. The chief of these was the ever-increasing heat in the tunnel, caused by the growing volume of water, which, though it percolates through beds of limestone from nearly 6,000 ft. above the line, becomes very hot and flows into the tunnel at a temperature of from 112 deg. to 140 deg. F., rendering not only work, but life, impossible, without artificial refrigeration. By turning cold air on hot air, and cold water on hot water, the temperature inside has been reduced to 70 deg. The volume of water flowing from the south end of the tunnel is over 15,000 gallons a minute, and furnishes power sufficient to work the refrigerating apparatus and to compress the air by which the drills are worked. When completed the tunnel will be longest in the world—14 miles, against seven miles for the Mont Cenis and nine for the St. Gothard tunnels. The cost will be 70 million francs, or five million francs per mile.

A portable air-compressing plant has recently been constructed for the Bengal-Nagpur Railway, India. The plant which is an interesting one, consists of an air compressor, arranged to be driven by an electric motor by gearing direct, of an air receiver, water tank and all accessories,

the whole being mounted upon a hand trolley suitable for a 4 ft. 8½-in. gauge.

The compressor, which is of the compound type, is capable of compressing 80 cub. ft. free air per minute to a pressure of 100 lbs. per sq. in. with the barometer at 29 inches.

The cylinders are fitted with cast-iron liners of special mixture and bored truly parallel, the space between the liner and the shell forming the water jacket.

The main bearings are formed in the compressor bed and are fitted with adjustable two-part gun-metal steps.

The driving gear consists of a cast-iron spur wheel fitted to the compressor shaft and a raw-hide pinion fitted on to the motor shaft.

The intercooler is of the pipe pattern, and provides a cooling surface of 16 sq. ft.

The air receiver, which is of steel, is 5 ft. 6 in. high by 2 ft. 6 in. diameter, of 25 cub. ft. capacity. The bottom end is dished inwards and is fitted with an angle-iron ring, for bolting to the truck.

The galvanized iron water tank is 10 ft. long by 3 ft. wide by 1 ft. 9 in. deep, and is provided with a loose lid 4 ft. long and fitted with rubber packing to prevent the water from splashing over when the trolley is moved.

The latter is built of mild steel of ample strength with forged eye-bolt at each end for coupling chain, and is also fitted with eye-bolts for lifting purposes. The axles are of mild steel 3½ inches diameter, and are fitted with four steel flanged wheels having suitable axle-boxes with oil wells.

The motor for this equipment has a speed of 700 revolutions per minute, and includes a suitable starting switch.

The compressor is fitted with a low-pressure cylinder 8 in. diameter, and a high-pressure cylinder 6 in. diameter, the stroke of both being 10 ins.

A patent automatic inlet valve is fixed on the inlet side of the cylinder, so that when the working pressure is exceeded the inlet is automatically closed, putting the piston into equilibrium by causing a partial vacuum on both sides of the piston. This allows the compressor to run free (or without resistance).

The cooling water is circulated, and at the same time cooled, by means of a small air-lifting jet fixed on the high-pressure cylinder.

INDEX.

U. S. PATENTS GRANTED APR. 1903.

Specially prepared for COMPRESSED AIR.

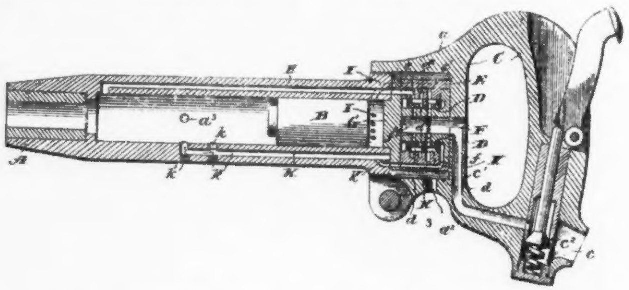
724,736. PNEUMATIC TOOL. Harold A. R. Prindle and John U. Adolph, Philadelphia, Pa. Filed June 19, 1902. Serial No. 112,-380.

The combination with a cylinder and a piston, of a valve having pressure-receiving surfaces to move it in opposite directions, means for intermittently applying pressure to one of such surfaces, and means for constantly applying a lower pressure to the other of such surfaces.

724,606. AIR AND GAS ENGINE. John B. O'Donnell, Kansas City, Mo.; Ella M. O'Donnell, administratrix of said John B. O'Donnell, deceased, assignor of one fourth to James R. Pollard, Kansas City, Mo. Filed July 24, 1902. Serial No. 116,825.

An air and gas engine comprising two cylinders disposed end to end, each containing a piston-chamber, with pistons therein mounted on a common piston-rod, center heads through which said rod passes, forming a partition between said chambers, compressed-air ports and gas-ports in the walls of said cylinders, upon each side, leading into said piston-chambers, valve-chambers interposed in the course of said air and gas ports having valves therein mounted on common, inwardly-projecting stems and controlling said ports, a longitudinal exhaust-passage in said partition, an exhaust-valve adapted to reciprocate therein, a governor located above the cylinders and having a depending stem, a cross-head on the lower end of said stem, a pendulum device suspended below said cross-head, having an adjusting-rod supported by said cross-head and mounted to rock thereon, an arbor forming the center of oscillation of said rod and pendulum, lateral arms pivoted at their lower ends to said adjusting-rod, and at their upper ends linked to said arbor, and lying between the projecting ends of said admission-valve stems, and means operated by the exhaust-valve for rocking said pendulum, so as to contact alternately with said stems and regulate the throw of said admission-valves.

724,688. PNEUMATIC-TUBE TERMINAL. Edmond A. Fordyce, Chicago, Ill., assignor, by mesne assignments, to Bostedo Pneumatic Tube Company, Chicago, Ill., a Corporation of Illinois. Filed June 16, 1900. Serial No. 20,542.



724,780. PNEUMATIC FEEDER. Edwin M. Bassler, Chicago, Ill., assignor of three-fourths to Eugene Worthing, Charles W. Rogers, and Julian W. Mathis. Filed July 5, 1902. Serial No. 114,416.

A pneumatic feeder, the combination of a hopper or receptacle for the material to be fed, a receiving-chamber communicating with the hopper, and an injector for an air-blast interposed between the hopper and the receiving chamber discharging into the latter and carrying the material thereinto.

724,830. PNEUMATIC TIRE. Wilbraham Edmunds, London, England. Filed Jan. 21, 1902. Serial No. 90,717.

725,127. MOTOR FOR PORTABLE TOOLS. Caid H. Peck, Elmira, N. Y., assignor to Imperial Pneumatic Tool Company, Athens, Pa. Filed June 9, 1902. Serial No. 110,-730.

A motor-driven tool, the combination of a casing, a head for the casing, admission and exhaust passages leading out from the center of said head, an eccentric shaft set between two disks secured to the head within the casing, a frame rotating upon said disks and a plurality of cylinders within the frame rotating upon the eccentric shaft, connections between the frame and cylinders whereby rotation is imparted from one to the other, ports and passages leading from the cylinders

through the eccentric shaft to the admission and exhaust passages in the head, a spindle projecting from the casing in line with said rotating frame, and means for transmitting motion from said frame to the spindle.

725,128. MOTOR FOR HOISTS OR OTHER APPLIANCES. Caid H. Peck, Elmira, N. Y., assignor to Imperial Pneumatic Tool Co., Athens, Pa. Filed June 9, 1902. Serial No. 110,731.

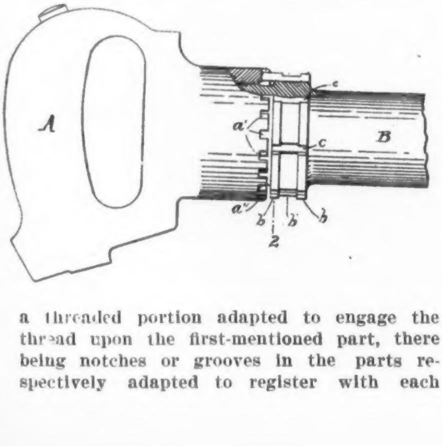
The combination with a tackle-hoist, of a casing, a motor within said casing coupled by a train of gears to a gear-head also contained within said casing, said gear-head and casing being adapted to be substituted for the hand-chain sprocket upon the hoist.

A complete article of manufacture, a casing, a motor to be driven by compressed air, or other fluid under pressure, and a reducing-gearing contained within said casing, the whole being adapted to be substituted for the hand-chain sprocket upon a hoist.

725,243. PNEUMATIC CLUTCH. Charles B. Goodspeed, Columbus, Ohio. Filed Oct. 3, 1902. Serial No. 125,806.

725,337. PNEUMATIC TOOL. Charles H. Haeseler, Easton, Pa., assignor to the Haeseler-Ingersoll Pneumatic Tool Company, New York, N. Y., a Corporation of West Virginia. Filed Sept. 18, 1902. Serial No. 123,833.

A pneumatic tool, the combination with the separable parts thereof, one part having a threaded end, the other part provided with

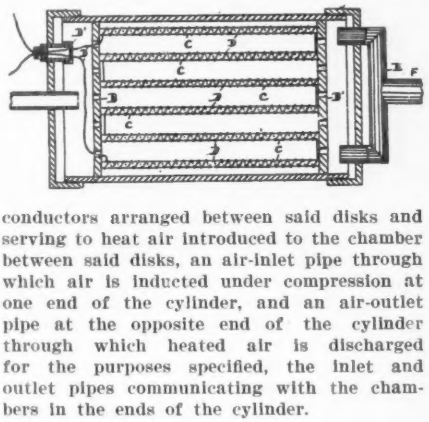


a threaded portion adapted to engage the thread upon the first-mentioned part, there being notches or grooves in the parts respectively adapted to register with each other, the number of notches or grooves in the respective parts differing one from the other and not being multiples of each other, of means through the medium of said notches and grooves to hold the parts together.

725,402. PNEUMATIC SIGNAL. Joseph H. Brady, Kansas City, Mo. Filed April 8, 1902. Serial No. 101,873.

725,450. AIR COMPRESSOR AND HEATER. Chas. R. Keller, Dayton, Ohio. Filed Feb. 9, 1901. Serial No. 46,602.

The combination in an electrical heating apparatus for heating air under compression, for motive power, a cylinder, two perforated disks arranged on the interior of said cylinder adjacent to the ends thereof, caps inclosing the ends of said cylinder and providing chambers between the perforated disks and said caps, a series of solid electrical



conductors arranged between said disks and serving to heat air introduced to the chamber between said disks, an air-inlet pipe through which air is inducted under compression at one end of the cylinder, and an air-outlet pipe at the opposite end of the cylinder through which heated air is discharged for the purposes specified, the inlet and outlet pipes communicating with the chambers in the ends of the cylinder.

725,588. APPARATUS FOR CONVEYING TOPS AND BOTTOMS OF CANS. John G. Rehfuss and Martin O. Rehfuss, Philadelphia, Pa., assignors to Bureau Can and Manufacturing Company, of Delaware. Filed May 6, 1902. Renewed Mar. 23, 1903. Serial No. 149,205.

A pneumatic conveyor for carrying tops and bottoms of cans to be applied to the body portions thereof, comprising a spring-actuated arm adapted to feed a top or bottom into said conveyor, and valves at the exit end of the conveyor normally held closed by the suction in the latter and designed to open under the impact of a top or bottom coming in contact therewith, as set forth.

725,624. PNEUMATIC STACKER. Chas. N. Leonard, Indianapolis, Ind., assignor by mesne assignments, to The Indiana Manufacturing Company, Indianapolis, Ind., a Corporation of West Virginia. Filed Feb. 16, 1903. Serial No. 143,657.

725,801. TRACK-SANDING DEVICE. Thos. E. Townsend, Mahoningtown, Pa. Filed June 26, 1902. Serial No. 113,250.

A track-sanding device, in combination, a valve, means for delivering sand thereto, a gravity feed-pipe leading therefrom, and means for delivering an air current to said valve, the latter adapted to control the air-current-delivering means and the flow of sand through said gravity feed-pipe.

725,964. PNEUMATIC FIRE-ESCAPE. Israel Hogeland, Indianapolis, Ind., assignor by mesne assignments, of one-half to Adaline P. Campbell, Indianapolis, Ind. Filed Oct. 14, 1901. Serial No. 78,552.

A pneumatic fire-escape, the combination with a truck, of a tower arranged thereon and comprising a series of vertically-extending telescopic tubes, a crib or platform arranged at the upper ends of said tubes and adapted to be removed thereby, a source of compressed air carried by the truck, a distributing and controlling valve connected to said source, pipes connecting said valve with said tubes, whereby the latter are supplied with the compressed air for operating the crib or platform, and a telescopic shaft arranged at the side of said tower and having its upper end extending to the crib or platform and its lower end connected to said distributing and controlling valve, said shaft being provided with means to effect its operation from the crib or platform, whereby the distributing and controlling valve may be operated from the crib or platform when the latter is either in motion or at rest.

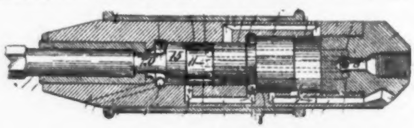
726,022. PNEUMATIC CARRIER. Charles H. Burton, Boston, Mass. Filed Dec. 3, 1902. Serial No. 133,663.

726,033. AUTOMATIC SWITCH FOR PNEUMATIC-DESPATCH APPARATUS. Frederick C. Cutting, Rochester, N. Y., assignor to Lamson Consolidated Store Service Company, Newark, N. J., a Corporation of New Jersey. Filed May 15, 1902. Serial No. 107,456.

726,072. SAFETY-VALVE FOR PNEUMATIC TUBES. August Koenig, Lowell, Mass., assignor to Lamson Consolidated Store Service Company, Newark, N. J., a Corporation of New Jersey. Filed Jan. 16, 1902. Serial No. 89,940.

726,074. PNEUMATIC TOOL. Herman G. Kotten, New York, N. Y. Filed July 17, 1901. Serial No. 68,593.

A pneumatic tool, a cylinder, a differential piston therein, a plurality of passages for admitting motive fluid to the exterior surfaces of the differential areas of said piston, and means for permitting the exhaust of the mo-

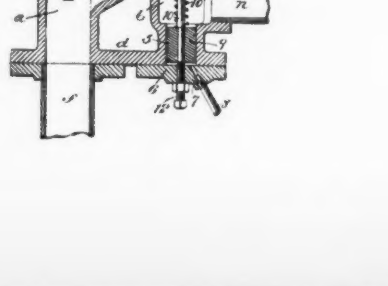


tive fluid from the small pressure area of said piston, when the latter has made its extreme backward stroke, without creating a cushion at the front of said piston when the latter delivers its forward blow to the chisel.

726,097. PNEUMATIC CARRIER. Otto S. Pike, Malden, Mass. Filed Jan. 28, 1902. Serial No. 91,597.

726,220. UNLOADING DEVICE FOR AIR OR GAS COMPRESSORS. William S. Fairhurst, Brooklyn, N. Y., assignor of one-half to John J. Riley, Brooklyn, N. Y. Filed July 8, 1902. Serial No. 114,750.

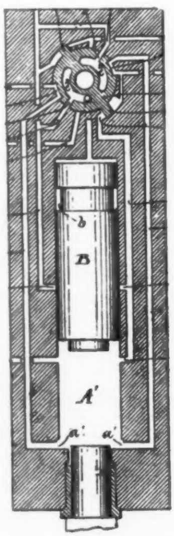
An unloading device for a compressor, a chamber in which is a valve-seat, an upwardly-opening relief-valve adapted to said



seat, a loading device applied to said valve for closing it, a cylinder in said chamber below the valve-seat having its lower part in communication with the receiver to which the compressor delivers, a piston in said chamber, a communication between said chamber and the outlet of the compressor above said valve, an outlet from said chamber to the atmosphere between said valve and piston, a spring interposed between said piston and valve for opening the latter and an adjusting-screw in the bottom of said cylinder for adjusting the piston therein to adjust the force exerted by said spring for opening the valve.

726,221. PNEUMATIC TOOL. Charles H. Haeseler, Easton, Pa., assignor to the Haeseler-Ingersoll Pneumatic Tool Company, New York, N. Y., a Corporation of West Virginia. Filed Oct. 11, 1902. Serial No. 126,904.

A pneumatic tool, the combination of a case provided with a piston chamber and piston therein, a valve-case, an axial valve



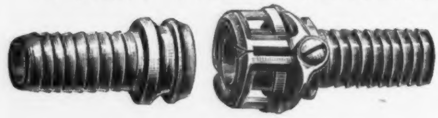
therein having chambers on opposite sides of its axis, openings extending from each of said chambers to the exterior of the valve and ports and passages leading from the pressure-supply and adapted in one position of the valve to register with said openings in the valve.

726,227. SUBMARINE BOAT. Simon Lake, Bridgeport, Conn. Original application filed May 28, 1901. Serial No. 62,207. Divided and this application filed Nov. 18, 1902. Serial No. 131,851.

The combination with the hull of a submarine boat, of a normally closed superstructure covering the upper portion of the same, means for admitting water to said superstructure, a discharge-pipe extending from the bottom of said superstructure to the top of the same, and provided with a normally open inwardly-closing check-valve, and means for admitting air under pressure to said superstructure to expel the water through said discharge-pipe.

726,459. AIR-BRAKE MECHANISM. Thos. J. Quirk, Buffalo, N. Y. Filed July 18, 1902. Serial No. 116,079.

PUSH THEM TOGETHER



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